Work Estimating Desk Guide

for
Planners and Estimators

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CHAPTER I
INTRODUCTION TO WORK ESTIMATING

A. PURPOSE

The Work Estimating Desk Guide is a training and reference book designed to aid in initial and refresher training of Planner/Estimators. Upon completion of training it can also be used by the student as a professional reference guide for answering questions related to work estimating. The Work Estimating Desk Guide provides:

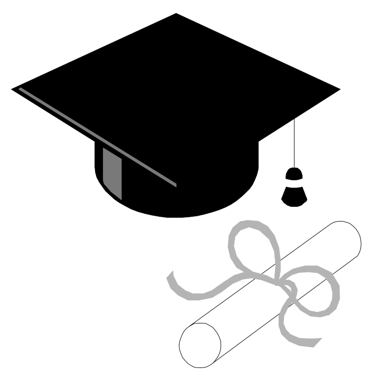
- background information relative to facilities maintenance management
- work planning and estimating fundamentals
- sources of estimating data
- instruction on work estimating for maintenance and repair
- instruction on work estimating for all types of recurring maintenance
- class exercises and problems
- appendices of helpful information related to work estimating

B. COURSE DESCRIPTION

The Work Estimating course is designed to provide structured work estimating training. It provides Planner/Estimators with:

- a comprehensive overview of the facilities maintenance management system and its components
- details on the dynamics of planning
- fundamentals of work estimating
- sources of estimating data
- Engineered Performance Standards (EPS) data application techniques

C. COURSE REQUIREMENTS



Planner/Estimators attending the Work Estimating Course should, at a minimum, have some craft or engineering technical background. However, the course is not limited to only Plannner/Estimators. Attendance may also prove beneficial to Planner/Estimator supervisors, shop foremen, and other facilities maintenance management personnel who rely on estimates as an integral part of their respective work functions.

D. LEARNING OBJECTIVES

Students completing the Work Estimating Course will be able to:

- describe the concept and components of a facilities maintenance management system
- describe the importance of effective facilities maintenance management
- describe various types of estimates

- develop a rough job plan
- select appropriate task and work standards
- describe the benefits of using standards
- apply EPS in conjunction with Non-EPS standards
- develop a complete work package including labor estimates, bills of material, equipment requirements, shop sketches, and job planning & estimating worksheets
- develop comprehensive estimates for a variety of recurring work

CHAPTER II
FACILITIES MAINTENANCE MANAGEMENT

A. OVERVIEW

Effective facilities maintenance management is the efficient control and utilization of Real Property Maintenance Activity (RPMA) resources. Responsibility for facilities maintenance at the installation level ultimately rests with installation/base commanders who rely on competent professional staffs to develop, manage, and execute RPMA operations and maintenance plans. Through the utilization of modern management concepts such as Total Quality Management (TQM), the responsibility for effective maintenance management is shared at all levels within the RPMA organization.

RPMA FACILITIES MAINTENANCE MANAGEMENT SYSTEM OBJECTIVES

- ***Provide proper and consistent levels of maintenance***
- ***Increase work force productivity***
- ***Attain the maximum practical return from resources expended***
- ***Insure standard and efficient methods of work control***
- ***Provide appropriate response to customer requirements***

The importance of effective facilities maintenance management in this era of ever shrinking defense budgets cannot be over emphasized. Well executed facilities maintenance management programs result in:

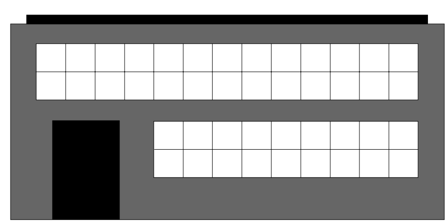
- better control of real property
- increased life span of aging facilities
- improved work force productivity
- enhanced service quality

B. FACILITIES MAINTENANCE MANAGEMENT SYSTEM COMPONENTS

A facilities maintenance management system is comprised of the components shown in Figure 2-1:

MAINTENANCE MANAGEMENT SYSTEM

A completely integrated group of components which provides control over facilities maintenance from beginning to end



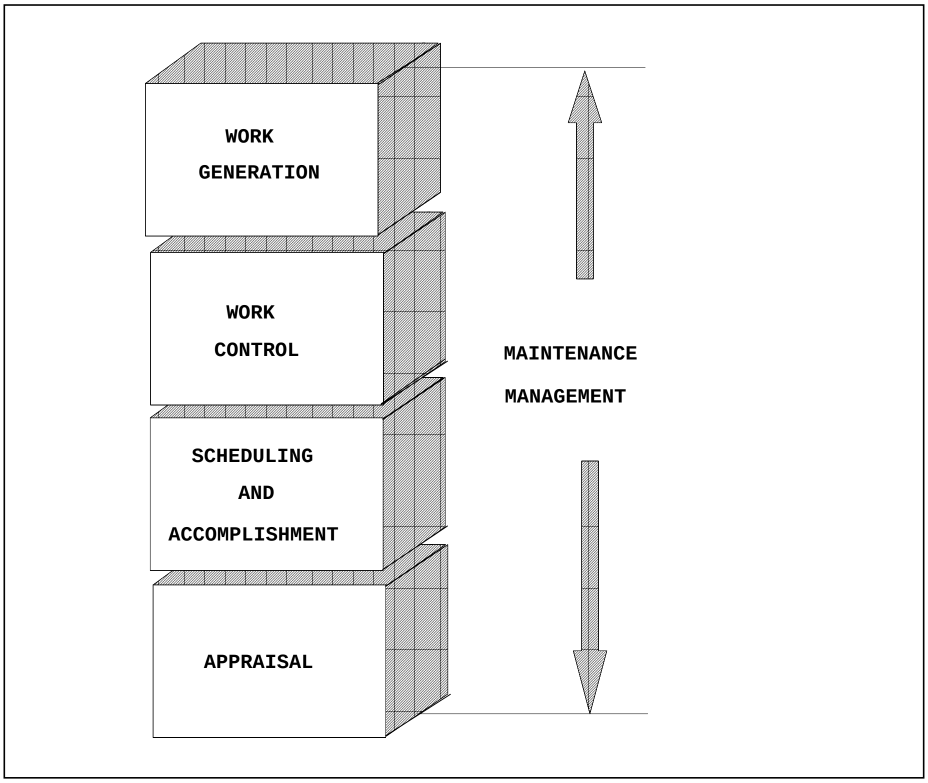


Figure 2-1. Facilities Maintenance Management System Components

1. <u>Work Generation.</u>
As depicted in Figure 2-2, there are several ways work can be generated.

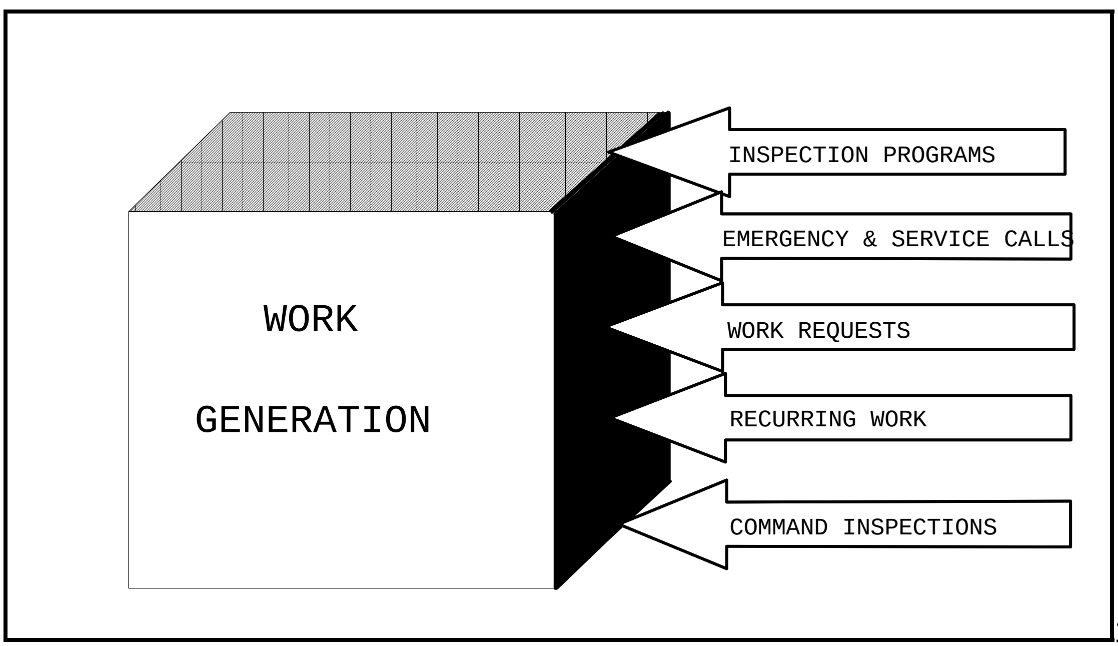


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Figure 2-2. Work Generation

a. Inspection Programs. Real property condition inspection performed by structural, mechanical, and electrical inspectors can be used in establishing a realistic backlog of work. Inspectors identify deficiencies and provide dollar estimates of the work and materials required to correct them. Condition inspections are the most pro-active type of work generation because they permit maintenance managers to plan for work accomplishment on the basis of severity of requirements and availability of resources.

CONDITION INSPECTIONS

The most pro-active type of work generation

Maintenance and repair work requirements can also be generated by personnel performing Preventive Maintenance Inspections (PMI) and routine operator inspections of equipment and systems in operation. These personnel report repair requirements discovered during the course of performing PMI, operator checks, or system operation. Reported repair requirements can then be estimated and performed based on the severity of the problem and funding constraints. PMI and operator generated work requirements are also pro-active in that the maintenance staff identifies the work and takes action to correct the problem versus experiencing a breakdown or having the customer identify the work requirement.

SERVICE CALLS

The most reactive and costly work performed by the RPMA organization

b. Service Calls. Customer generated requests for minor maintenance and repair requirements are the most reactive and customer visible work performed by the RPMA organization. This work has a high level of customer interest and requires quick response. It may, however, be the most costly work performed by the RPMA organization due to unpredictable demand, undefined work requirements, multiple work locations, and unsuitability for scheduling. Inherent are high levels of indirect productive time associated with travel, material acquisition, job planning, and troubleshooting.

c. Work Requests. Work Requests for work exceeding the minor maintenance and repair parameters of a service call are generated by authorized installation customers. They provide a continuous source of work generation within a facilities maintenance organization. Work Requests have the following characteristics:

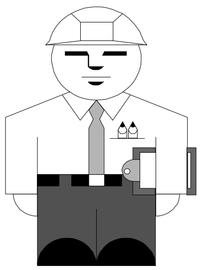
- definable work
- level of effort can be estimated
- predetermined material requirements
- readily planned and programmed for accomplishment
- easily scheduled
- highly productive elements

d. Recurring or Standing Work Requests. Most of this work is estimated on an annual basis and accounts for a significant percentage of a maintenance organization's productive labor hours. Although much of this work may be performed by contract, Planner/ Estimators often develop labor hour estimates to validate contractor bids as well as develop estimates for work performed by in-house resources.

RECURRING WORK

- ***Refuse collection***
- ***Grounds maintenance***
- ***Janitorial services***
- ***Plant operations***
- ***Preventive maintenance of equipment & systems***

e. Command Inspections. Command inspections are inspections which occur on a scheduled or unscheduled basis to determine maintenance, safety, or health deficiencies. In some cases these inspections are the result of regulatory requirements to determine compliance with OSHA, environmental regulations, or the status of special interests such as asbestos, PCB, or lead based paint contamination. These inspections normally result in deficiencies that are tracked with command interest until completion, resolution, or compliance.



2. <u>Work Control.</u>

The work control function, as shown in Figure 2-3, enables the large input of work from all work generation sources to be handled efficiently and effectively based on criteria such as cost, urgency, and capability. Work control normally includes the processing and control of all work from the time it is identified until the time it is accomplished (either by the shops or by contract) or canceled.

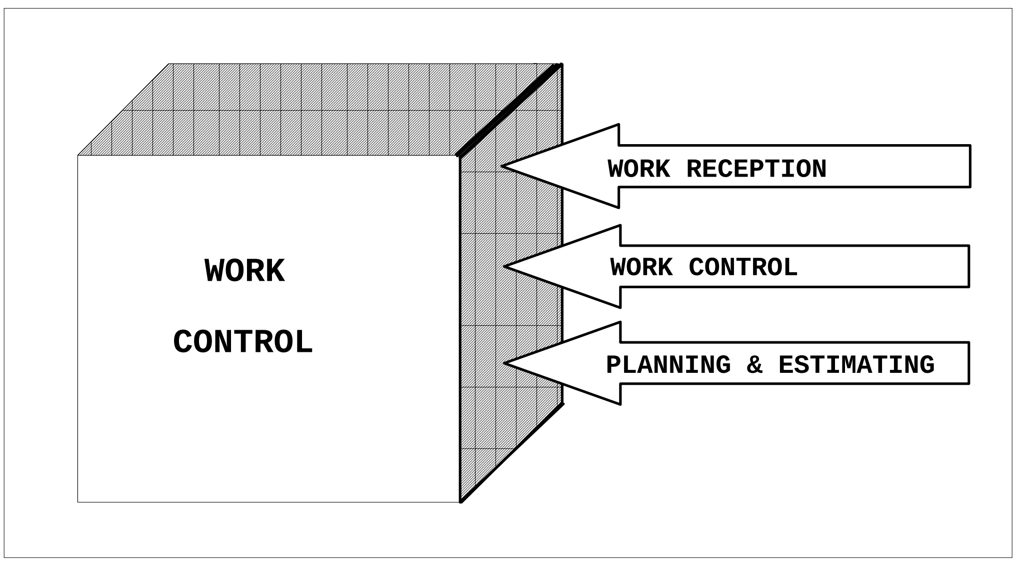


Figure 2-3. Work Control

a. Work Reception. Work reception is the point within the work control function where all identified work enters into the facilities maintenance management system. It is the point where:

- initial customer contact is made
- internal work screening and classification occur
- formal work document numbers are assigned
- customer interface for work status updates occur

b. Work Control. After a work requirement has been identified and documented through work reception, the work control function is responsible for screening each Work Request. Work Control determines:

- the type of work and relative urgency of the requirement
- whether a scoping or preliminary estimate is required
- if the funds for the work are available

If the work is approved for accomplishment, shop workload is examined to determine if the requested work should be performed in house or by contract. Work that is approved without available funds is considered unfunded backlog.

c. Planning & Estimating. Approved Work Requests are planned and estimated by Planner/Estimators to determine labor hours, material, equipment, and costs. Preliminary or scoping estimates may be developed to assist in the work screening process. Detailed estimates are developed when the decision is made to proceed with work accomplishment.

WORK ESTIMATING PROCESS
3 MAJOR ACTIVITIES

(1) Determine the work requirement
(2) Plan the work
(3) Estimate labor, material, and equipment requirements

Detailed estimates are the basis for scheduling shop hours and equipment and ordering the materials and parts required to complete the work. They provide the shop foremen with information on which to base work assignments, and serve as the basis for work appraisal when the jobs are complete. Because these estimates are an integral part of the facilities maintenance management system, they should only be done by individuals who have the pertinent technical background and proper training to produce accurate estimates and complete work packages.

3. <u>Work Scheduling and Accomplishment.</u>

Once a detailed estimate has been developed, reviewed, and approved, materials are ordered. As material is received it is staged for in-house work accomplishment. When all the material is in hand, the scheduler is notified that the job is available for scheduling. The scheduling and accomplishment function is depicted in Figure 2-4.

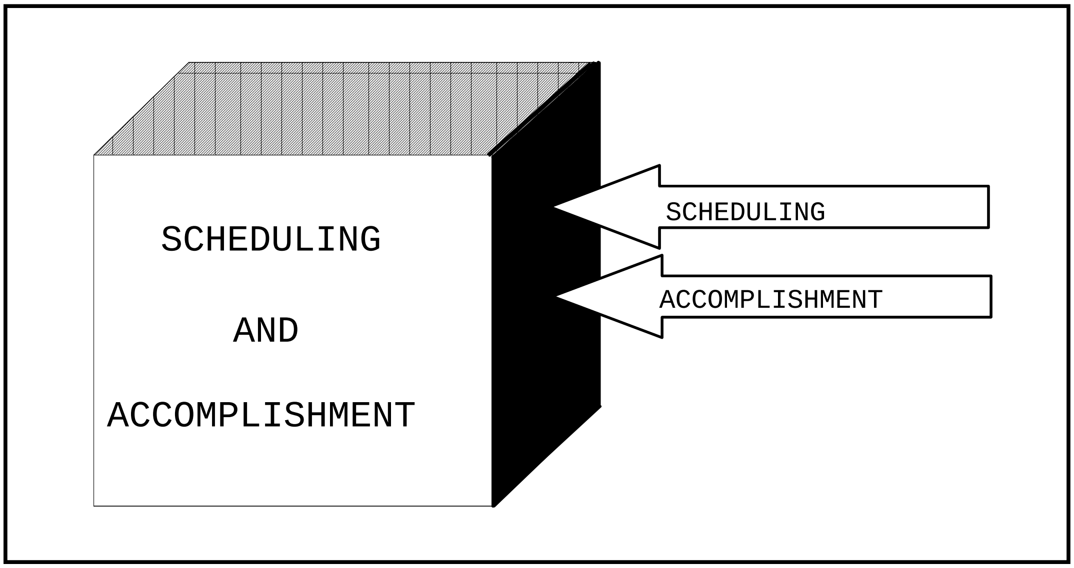


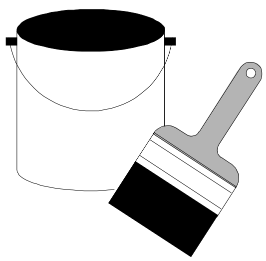
Figure 2-4. Work Scheduling and Accomplishment

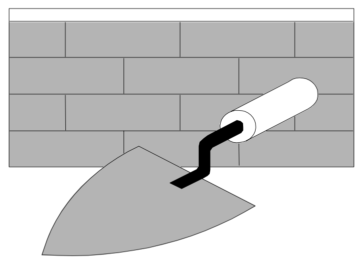
a. Scheduling. Scheduling is the assignment of labor resources to identified work requirements for accomplishment in a defined time frame. The objective of scheduling is to efficiently accomplish work according to the resources available. For in-house work, scheduling is done on a shop by shop basis. This approach insures that the work is ready to be performed when the craftspersons are available. It is important that the necessary equipment be available as planned and materials be staged or available. It is equally important that each assigned shop be ready and available to accomplish their designated job phases in the planned work sequence.

Scheduling occurs at two levels. Initially scheduling is the responsibility of the scheduler. This individual schedules shop hours on a master schedule based on long and short range plans provided by work control. The scheduler develops a weekly schedule which is distributed at shop scheduling meetings where shop foremen discuss the schedule to ensure that all the planned work can be accomplished.

The second level of scheduling is the day to day assignment of work by the shop foreman or shop planner. Each shop foreman is responsible for coordinating with the other shop foremen involved in a job to ensure that the work sequence of a job is maintained. The goal is to avoid long delays between job phases. The shop foreman provides job status and feedback to the scheduler so that the schedule can be updated as work is completed.

b. Accomplishment. Work accomplishment is the responsibility of the shop foreman and the craftspersons in the shop. The shops are responsible for performing work in accordance with the job plan and within acceptable quality levels. Craftspersons are responsible for notifying the shop foreman of changes in job scope discovered after the actual work begins. Shop foremen coordinate scope changes with the Planner/Estimator who estimates approved scope changes and provides the scheduler with hour adjustments. It is important that actual labor hours required to perform the work are captured and reported accurately.





4. **Appraisal.**

To complete the facilities maintenance management system, an appraisal process is used to look at the efficiency and effectiveness of the work being performed (Figure 2-5) and take action to improve, reduce, or eliminate operational problem areas.

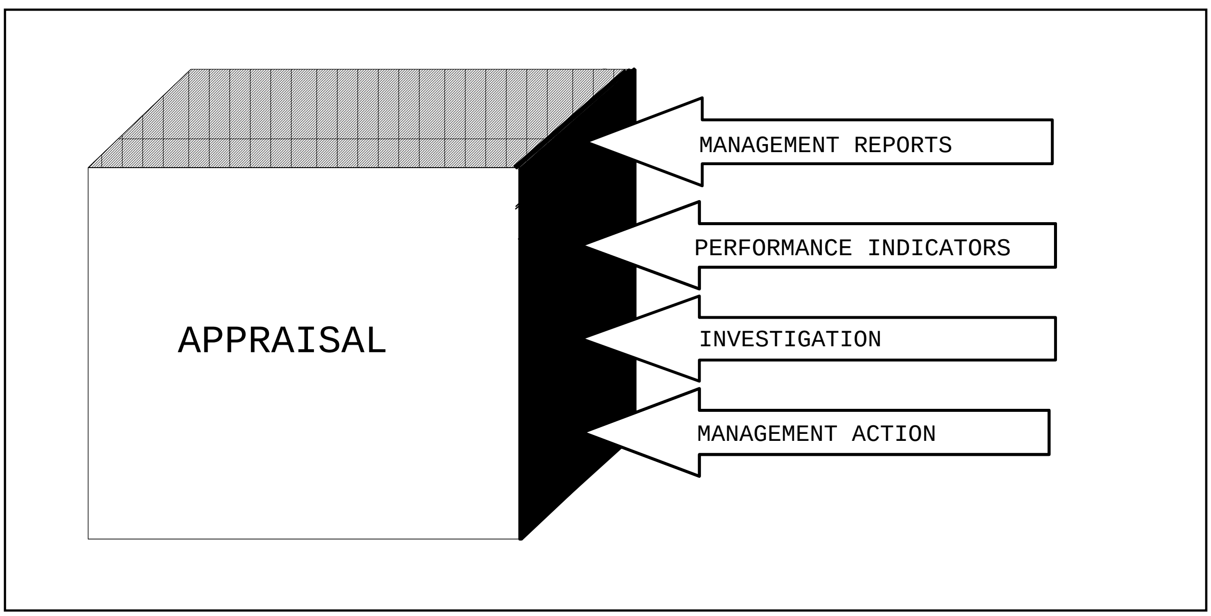


Figure 2-5. Appraisal

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a. Reports. When work is completed, job data is compiled into reports showing estimated versus actual labor hours and costs expended. This data is forwarded to management personnel for variance analysis and management action.

WORK APPRAISAL IDENTIFIES:

- ***Transportation problems***
- ***Communication problems***
- ***Material acquisition problems***
- ***Poor work methods***
- ***Resource shortages***
- ***Planning and estimating problems***
- ***Corrective actions to take to eliminate process problems***

b. Variance Analysis and Performance Indicators. Careful variance analysis of management reports aids in determining the root causes of unusual situations occurring during work accomplishment. This analysis should be conducted shortly after work completion to allow for further investigation. (See Appendix F for additional information on variance analysis.)

Performance indicators are a management tool within the work appraisal process. Management reports based on work data provide information for establishing performance indicators. Some of the many useful performance indicators may be used to monitor:

- labor, equipment, and materials expended
- actual versus estimated costs
- actual versus estimated labor hours
- job status
- work accomplishment

Tracked over time, these indicators provide a basis for comparative analysis, data for performance appraisals, and as a basis for decisions regarding whether corrective actions are needed to improve work processes. Analysis can also be conducted to determine whether previously implemented corrective actions are proving effective.

c. Investigation. In order to determine what job situation occurred to cause a variance, an investigation of the previously completed work must be undertaken. The results of this investigation should point to the root cause of the problems causing the variance and pave the way for management action.

d. Management Action. Soon after a determination is made on the causes of the problem areas, managers may be able to find methods for corrective action. Once implemented, reoccurrence of similar problems in the future may be eliminated or reduced.

C. FACILITIES MAINTENANCE MANAGEMENT SYSTEM INTEGRATION

SYSTEM COMPONENTS

For a facilities maintenance management system to run smoothly, all of its components must be operating:

- ***Work Generation***
- ***Work Control***
- ***Scheduling and Accomplishment***
- ***Work Appraisal***

As functions of the maintenance management system, the system components are totally integrated. They support each other as well as the system as a whole. For work to be performed efficiently and economically, personnel working in the respective functional areas must work together toward the common goal of keeping a smooth flow of work through the system. Personnel in the facilities maintenance organization should understand their job responsibilities and the effect their work has on other functional areas. Standard operating procedures (SOPs) should be developed and periodically updated to ensure that work moves through the system smoothly and efficiently.

Appraisal results should not be used to place blame on other system components or particular individuals within the organization. Rather, the work appraisal function should serve as a means of identifying work process problems so that continual system improvement can occur. Managers should use the information provided in management reports, performance indicator programs, and system analyses as a basis for making positive corrective changes in the processes supporting the operation and maintenance effort.

CHAPTER III
WORK ESTIMATING

A. DEFINITION

Work estimating is defined as follows:

> **WORK ESTIMATING**
>
> ***The process used to determine requirements, plans, and estimates to accomplish a defined amount of work.***

As presented in Chapter II, the work estimating process is part of the work control function in a facilities maintenance management system. It provides both planning and work accomplishment support within the function. Its dual purpose necessitates two types of work estimates.

B. TYPES OF ESTIMATES

1. <u>Scoping Estimates.</u>

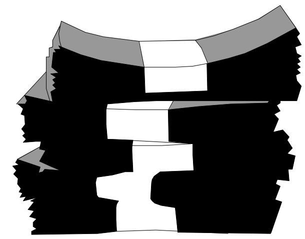
Scoping estimates are preliminary or "ball park" estimates used in the work control screening process to determine if the requested work should be performed. If the work is to be performed, scoping estimates can aid in determining whether the job is accomplished in house or by contract. The estimates are provided to customers who want to upgrade or repair their facilities, but, first, want to know how much the changes will cost before they decide to commit resources to the project. They are also developed to obligate funds prior to development of a complete job package. To meet these various planning purposes there are three types of scoping estimates:

> **SCOPING ESTIMATE**
> ***For planning purposes, provides an approximation of effort and dollars required to perform job.***

a. Desk Top Estimates. Desk top estimates are, as the name implies, normally developed at the Planner/Estimator's desk. The estimate is based on one of many types of unit price standards estimating methods:

- R.S. Means™ for new construction and maintenance work
- Walkers™ for new construction and alterations
- Facilities Engineering Job Estimating (FEJE) Unit Price Standards (UPS) for maintenance and repair
- Job Order Contracting (JOC) standards for minor alterations and repair work

These estimates are considered to be ± 25% accurate.



b. Funded Estimates. Funded estimates are more accurate than desk top estimates because they are used to obligate resources. For these estimates, the Planner/Estimator usually makes a site visit to determine the work and material requirements and incorporates them into the scope of the estimate. Similar to desk top estimates, unit price standards are used to arrive at the estimated labor and material costs.

c. Inspection Estimates. Inspection estimates are developed by inspectors as a part of a facilities condition inspection program. These estimates facilitate the work control screening process by providing the facilities manager with reliable information for use in determining near term accomplishment or backlog requirements. Deficiencies found and scope of repairs are determined by the inspector. These serve as the basis for developing an inspection estimate and a Work Request document.

2. <u>Detailed Estimates.</u>

Detailed estimates for in-house and contract work are developed to determine the following:

- specific work requirements
- work sequencing
- craft tasks
- labor hours
- specific material and equipment quantities
- total dollars required

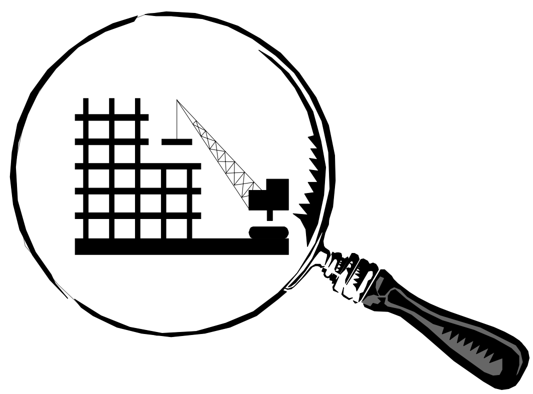
Detailed estimates are based on field validation site visits. They contain:

- a detailed sequence of the job phases and craft phases
- detailed descriptions of the work tasks to be performed
- sketches, diagrams, and maps
- detailed bills of material

Detailed estimates for in-house maintenance and repair work require application of standard data to maintain consistency and accuracy.

DETAILED ESTIMATE

Determines labor and material resources and provides detailed information on the requirements to schedule and perform a job.



3. <u>Service Calls.</u> Service calls consists of the minor maintenance and repair requirements that arise in the course of facilities operations. The exact definition of service work varies from installation to installation based on specific dollar or labor hour thresholds. Service requirements are:

- not too complex
- involve limited amounts of materials
- generally involve only one craft or trade in their accomplishment
- normally not planned and estimated by Planner/Estimators

Service call estimates are generally made by the service work receptionist who receives customer requests. Based on the customer's description of the problem, the clerk assigns an estimate from a book of service standards. Service call estimates provide the work control function with an estimate of the shops' service work backlog and give the shop foremen an idea of the magnitude of the work being assigned. (See Appendix E for more information on service call estimating).

C. PLANNING AND ESTIMATING ACTIVITIES

The work estimating process for both scoping and detailed estimates consists of three principal activities.

WORK ESTIMATING ACTIVITIES

- ***Determine the work requirements***
- ***Developing a work plan***
- ***Estimate the labor and material needed to accomplish a defined amount of work***

1. <u>Determine Requirements.</u>

Identifying all the requirements of a job is essential to developing a good estimate. When the Planner/Estimator receives a Work Request from work control, the customer generated description may not be well defined. Even if a Work Request has been developed by a facility condition inspector or a craftsperson, it may not contain sufficient detail to fully determine all the work requirements. There are four steps to determining the requirements of a job.

STEP #1: READ THE WORK REQUEST

Reading the Work Request sounds simple. However, there is more information on a Work Request than the basic description of work. For instance, the date the request was received in Work Reception is very important:

- older Work Request work descriptions may have changed
- the scope of work can increase or decrease over time
- changes in customer personnel may result in different ideas about the work requirement
- the requirement may no longer exist

The Work Request also contains a Point of Contact and a phone number the Planner/Estimator can call to discuss the work to be performed and arrange for a site visit.

STEP #2: TALK TO THE CUSTOMER

Talk to the customer by phone in conjunction with a desk top estimate and in person at the job site for a funded estimate or detailed estimate. These conversations can prove invaluable for determining the work requirements. By talking to the customer, a clearer description of the work is gained which helps to ensure that the job meets the customer's expectations when it is completed.

STEP #3: VISIT THE JOB SITE

For detailed and funded estimates, a site visit helps to accurately determining the work requirements. This work validation visit allows the Planner/ Estimator to investigate the requirements in terms of the magnitude of the work to be done.

JOB SITE VISIT

- ***Take measurements***
- ***Draw sketches***
- ***Identify material requirements***

The Planner/Estimator can also obtain a general sense of the surroundings in which the craftspersons will be working. While at the work site, the Planner/ Estimator should:

- look into where materials and tools can be stored
- consider the effects of dust or noise on customer personnel
- determine if power outages are required and inform the customer
- determine access requirements such as escorts and clearances

If possible, arrange to meet the customer's Point of Contact at the job site so that work requirements can be discussed. Throughout the field visit, the Planner/Estimator should take notes to ensure that all the relevant details are gathered during the visit and eliminate the need for additional site visits.

STEP #4: COLLECT RELATED SITE INFORMATION

Within the facilities engineering organization, a great deal of information is available to help the Planner/Estimator develop a good work estimate.

- **Facilities Plans** - provide graphic renderings of a facility's structural and mechanical components. The specific area where the work is to be performed can be studied on these drawings to determine measurements and equipment information vital to the work requirements of the job. These drawings can also be copied and portions provided as drawings in the work package to facilitate the craftspersons' understanding of the work requirement.

- **Equipment Manufacturer Data** - helps the Planner/Estimator ensure that the work requirements identified are within the parameters of supporting pieces of equipment or within the manufacturer's specifications.

- **Facility History Files** - contain past work performed giving Planner/Estimators insight into what may be required as a part of the job to be estimated. For recurring work, a review of the previous year's estimate compared to the actual work accomplished should be done.

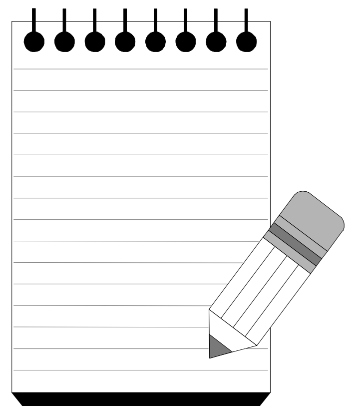
Having a clear understanding of the work requirements is essential to developing an estimate that accurately defines the amount of work to be done. When the work requirements are not thoroughly researched and identified, the negative effects ripple throughout the work estimating process and subsequently throughout the facilities maintenance management system. Excessive changes in scope are generally the most noticeable results.

SCOPE CHANGES

- ***Increase costs to the customer***
- ***Result in additional inconvenience and disruption as the job completion time expands beyond what was anticipated***
- ***Cause delays associated with ordering additional materials***
- ***Cause scheduling problems when craftspersons have to work longer than scheduled at a particular work site***

2. Develop a Work Plan.

"Plan your work, then work your plan."



This saying is one of the principles of effective mainte-nance management. Planner/Es-timators must plan the work so that a clear, concise, estimate is developed. Regardless of whe-ther the end product is a scoping estimate or a detailed estimate, job planning is essential to ensure that the estimate accurately reflects all the work, crafts to be used, equipment required, and materials to be used. After the work requirements have been determined, the Planner/Estimator develops a rough job plan. The following are the detailed steps for developing a rough work plan:

STEP #1: DETERMINE WORK SEQUENCE

Determine craft sequence based on the way in which the shops work.

- **Single Trade Shops** - At many installations, each trade works independent of the others. Carpenters do only carpentry work, electricians only electrical work, etc. In developing the work sequence, the Planner/Estimator must consider the way the trades must be sequenced to accomplish the work requirements. Each time a trade goes to the work site, a separate job phase must be planned.

EXAMPLE

REQUIRED WORK:

Put a new wall into room 300 to divide the room into two rooms - 300 and 301.

WORK SEQUENCE:

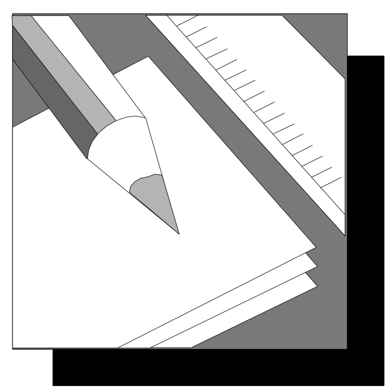
Carpenters: Frame in wall
Electricians: Rough in electrical requirements
Carpenters: Hang the dry wall
Painters: Paint walls
Electricians: Finish electrical work.

- **Multi-Trade Shops -** In recent years, many installations have gone to what is known as multi-trade shops. Although a craftsperson is a carpenter or electrician by trade, each craftsperson is required to help the other trades at the work site during the performance of the job. In the case of the above example in a multi-trade shop, the foreman would send an electrician and a carpenter to the site. The electrician acts as the carpenter's helper while the carpentry work is done and the carpenter assists the electrician with the electrical work. One or both craftspersons paint the wall.

Work sequencing is discussed in more detail in Chapter VIII; however, it is important to initially sequence the job during the work planning process to establish the basis of the work plan. It also helps in the preliminary identification of the tasks associated with the accomplishment of the work requirement.

STEP #2: MAKE ROUGH SKETCHES

After a field visit and conference with the customer's Point of Contact, the Planner/Estimator should develop a rough sketch of the work requirement including dimensions and other relevant information. This sketch can help to identify the tasks associated with the work to be done and provide the basis for a rough estimate of the material quantities needed.

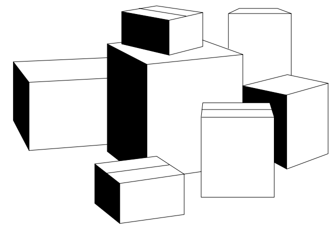


STEP #3: IDENTIFY THE WORK TASKS

For each phase in the sequence of work requirements, a preliminary list of tasks required to accomplish the job is developed. This list provides a starting point for identifying the standards to be applied when the detailed estimate is developed. It also gives the Planner/Estimator notes on which to base discussions about the work with the various shop foremen to be involved in the work accomplishment and with other Planner/Estimators who might be able to provide insight into methods and techniques for more effective work accomplishment.

STEP #4: IDENTIFY THE MATERIAL REQUIREMENTS

A rough estimate of the materials required for the job and the quantities of materials (including sufficient amounts for waste, cut outs, and trim-to-fit work) should be developed for each phase in the work sequence. Since material requirements are based on quantities of work, it is extremely important accurate measurements and sufficient notes are taken. This will allow as complete and detailed a material list as possible without making multiple trips to the job site.



STEP #5: DEVELOP AN ESTIMATE

The rough work plan forms the basis for the estimate to be made.

- **Scoping Estimates** - For each task identified in the rough plan, the Planner/Estimator identifies the appropriate unit of measure for the task and the number of units associated with the work requirement. Using one or several of the unit price standard estimating methods, an appropriate standard is selected for the task. The predetermined standard cost per unit is then multiplied by the number of estimated units of measure to obtain an extended cost per job requirement. When all the extended costs for the job requirements are added together, the total represents the scoping estimate cost for the job. Unit price standards include equipment and material requirements as part of the unit cost.

- **Detailed Estimates** - The rough plan provides the Planner/Estimator with a working document to be used as the basis for discussions with the shop and subsequent development of the detailed estimate.

3. <u>Interface with Shops.</u>

After the rough work plan is done, the Planner/ Estimator should consider discussing the job with shop foremen. Their expertise, knowledge of shop resources, and familiarity with the facility can assist the Planner/Estimator in identifying:

- special equipment and material requirements
- additional tasks that may be required
- tasks that are not required

In the facilities maintenance organizations of today, many Planner/Estimators find themselves planning in trades in which they have little experience. Thus, identifying all tasks required to accomplish a job and ordering the right materials for the job may be difficult. Interfacing with the shop foremen and traveling out to the work sites together can improve the quality of an estimate and make the foreman's and planner’s job much easier. Two heads are often more effective than one.

D. DETAILING THE ESTIMATE

After the work requirements have been identified and the rough work plan developed, the detailed work estimate for the job is developed following these steps:

STEP #1: WRITE CONCISE PHASE DESCRIPTIONS

It is important that the phase description "stand alone" because the craftsperson is usually given only the phase descriptions and the attached sketches from which to work. The craftsperson should not have to call the Planner/Estimator or shop foreman for clarification.

CONCISE PHASE DESCRIPTIONS

- ***Allow the craftsperson to easily locate the work site***
- ***Determine the exact work requirements***
- ***Begin work within minutes of arriving at the site***

STEP #2: IDENTIFY THE WORK STANDARDS

Planner/Estimators have a wide variety of standards from which to choose. For maintenance and repair work, Engineered Performance Standards are engineered standards that have been developed specifically for this type of work. Planner/ Estimators should first look for the work tasks in EPS. If there are no applicable standards in EPS, other accepted standards methodologies should be investigated. As a last resort, if the task cannot be found in other standards application methodologies or manufacturers' guides, a "best guess" or local estimate can be made.

STEP #3: DEVELOP THE BILL OF MATERIALS (BOM)

The bill of materials is a concise listing of materials and parts required to perform the work in each job phase of the work sequence. The development of accurate bills of material is critical to efficient job accomplishment and the ability of Supply to effectively support the shops' work effort. Planner/Estimators must insure that the correct type, size, color, material composition, stock number, part number, and quantities are indicated on the bill of materials. Ambiguity in material identification may result in incorrect material orders or unsatisfactory material substitutes. Incorrect materials are not usually discovered until the work is about to begin, with the following possible results:

- work cannot begin
- incorrect materials returned to Supply
- correct materials reordered
- shop and Supply productivity impacted
- non-productive time charged to the job

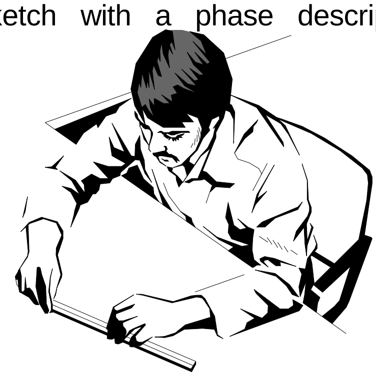
Failure to order sufficient quantities of material to allow for waste or complex cuts can also severely impact both productivity and the labor hours charged to the job. A craftsperson may not be able to obtain needed materials from stock causing an entire work process to stop. In addition, other craft phases may not be able to do their work as scheduled, and the customer's facility may be left in disrepair until material arrives.

STEP #4: DEVELOP SKETCHES AND MAPS

The phrase "a picture is worth a thousand words" most certainly applies to work estimating. In many cases a simple site sketch can help both the Planner/Estimator and the craftsperson. In drawing the sketch and placing the measurements on the drawing, the Planner/Estimator can better conceptualize the work requirements and see the material requirements in their proper perspective. The sketch may help avoid the material shortage scenario described above. For the craftsperson, an attached sketch with a phase description can minimize job planning and allow the craftsperson to begin work within minutes of arriving at the work site. Something as simple as indicating a room's location within the building may save valuable craft time in locating the work site. A sketch may also affect where the craftspersons park their vehicle, saving them from parking at one end of the building only to find the work at the other end.

SKETCH

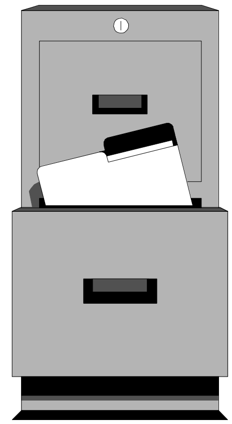
A drawing or sketch is one of the most effective ways of communicating a complex work requirement.



E. SUMMARY

The work estimating process is an essential component of Work Control. Scoping estimates are the basis for planning work accomplishment within the facilities maintenance system. Detailed estimates are the basis for ordering materials, scheduling and accomplishing work, and subsequently evaluating how well the facilities maintenance management system supports the craftsperson's accomplishment of work requirements. Not only the Planner/Estimators but all the facilities maintenance personnel need to understand the work estimating process and its integrated relationship with all functions of the facilities maintenance management system.

CHAPTER IV
SOURCES OF ESTIMATING DATA



There are five very broad categories of facilities maintenance estimating data. Within these categories are numerous sources of maintenance, repair, alteration, operations, and construction estimating standards. The categories of estimating data and location of some of the more well known sources of estimating data are presented below. In choosing from the categories and sources, Planner/Estimators should be aware of the applicability of the data to facilities maintenance and repair work requirements, the ease of use, and degree of accuracy provided.

A. HISTORICAL INFORMATION

Facilities maintenance Planner/Estimators have access to years of historical data related to operations, maintenance, and repair work performed at their installations. Historical data can be found in hard copy in Work Request files and facility history folders in installation work control offices. Dependent upon the thoroughness of the filing system, records may date back to the day a building was turned over to the installation. In electronic databases current jobs are usually resident in the active or historical directories with periodic purges sending the older historical records to archive files. Also in the electronic mode, Planner/Estimators may find some historical information on frequently repeated tasks stored as "local standards" in the system's standards database.

HISTORICAL DATA

- ***Provides the amount of time estimated to accomplish similar work***
- ***Provides the amount of time spent accomplishing similar work***

The applicability of historical data to a job or task for which estimating information is being sought is questionable. Unless the Planner/Estimator searching is the Planner/Estimator who developed the original work package, the applicability of historical information becomes questionable because too many unaccountable variables exist. For instance, the questions arise:

- Were the working conditions the same?
- Did the work go as planned or was the scope changed and not recorded?
- Were the work requirements exactly identical?

Finding the historical information sought is often easier said then done. If the data is in the electronic system, the search may be easy; however, if it has been archived and stored, getting it back into the database may take more time, effort, and expense than simply producing a new estimate. Most hard copy historical job related information is not sorted in a manner that lends itself to easy retrieval. If it is filed by facility number, the search may prove easy when the facility number is known. However, if it is stored by work order number, date completed, type of work, or customer the search may be long, frustrating, expensive, and ultimately unsuccessful.

Similar to the applicability of the old job to the new, the accuracy of historical information may be unreliable. Age may have an effect on the methods, materials, and tools used and affect the new estimate. A comparison of the estimate to the actual hours may show that a significant variance occurred that was never resolved. Does the Planner/Estimator choose the actual or the estimated hours as the basis for the new estimate?

There is no way to know the answers to all the questions that arise when a historical job is selected as a source of work estimating data. To level off the numerous variables, averaging a number of similar jobs and using the mean as a standard improves the accuracy somewhat. This approach provides a better estimate than a single job because it levels off the extremes, but still leaves open for question the reliability of the work estimating data it provides.

B. EXPERIENCE

1. <u>Planner Estimator.</u>

Estimator and craft experience are two areas of another broad category of estimating data. In the commercial world, estimators often provide scoping estimates for roofing, siding, gutters and window replacement, heating and air conditioning replacement, etc. Their experience in the field, their knowledge of materials they routinely select, and the large number of estimates they make in the course of a year enable them to rely on their experience as a source of estimating data. These "ball park" estimates are provided to potential customers over the phone or at the conclusion of a site visit. They are not used to formally commit the company in a contract. If given over the phone, a site visit to validate the scope and site conditions is made and measurements taken so that material requirements can be determined. If based on a site visit, the detailed estimate is either developed on the spot or mailed within a couple of days of the visit.

Craft experience or estimating experience enables a Planner/Estimator to produce reasonably accurate estimates for specific kinds of work in a specific area. Experience can be rapidly applied to scoping or desk top estimates. If the Planner/Estimator keeps comprehensive field notes, the material requirements are easy to copy and modify as required to match the scope of the new job. The accuracy of experience estimates is only as good as the Planner/Estimator's estimating skill and memory.

2. <u>Other Experts.</u>

If the Planner/Estimator consults other persons for estimating information outside the Planner/Estimator's personal knowledge base, the variables associated with applicability and accuracy of the data increase. Questions arise:

- Is this individual's knowledge and experience really sufficient to accurately estimate the work requirements?
- Have the work requirements been clearly defined?
- Are the work requirements understood by the person who is to make the estimate?

For scoping purposes, experienced estimates by others may be sufficient. There are other Planner/Estimators and craftspersons at the installation and many commercial vendors who perform similar work in the neighboring communities. Unfortunately, determining the accuracy is difficult. Many times this information is provided off the top of the estimator's head based on their best recollection of a similar job that was done in the past. Personal biases must also be factored into the estimate. A foreman may tend to estimate high to ensure the shop has sufficient time to accomplish the work. A commercial vendor may estimate low because the work is routine for the company and therefore something the craftspersons do on almost a daily basis.

C. CONTRACT DATA

In recent years, an increasing amount of facility maintenance work has been performed by contract. Information on contract bids and government estimates is available in hard copy or in the maintenance management information system at the installation. In fixed price contracts, the contractor provides a price for the work and provides no detail in the invoice sent for reimbursement. Even if the estimate contains labor hours and materials for each work requirement of the job, there is no guarantee that those labor hours reflect what the contractor's work force might use for accomplishment of the work.

> **CONTRACT DATA**
> ***Basing an estimate on contract data is risky because the accuracy is totally unknown.***

D. STANDARDS

A standard is defined as follows:

> **STANDARD**
> ***A measure of comparison or acceptability used as a bench-mark or yardstick for measuring actual performance.***

In facilities maintenance management, standards provide a benchmark (expressed in either dollars or hours) for a defined amount of maintenance work to be accomplished. When work is completed, the standard becomes the basis for comparison of actual performance. The comparison can assist in finding:

- problems in the process which prohibit craftspersons from performing to standard
- where work processes promote performance allowing craftspersons to exceed the standard

Two types of standards data are available to facilities maintenance organizations.

1. <u>Proprietary Standards.</u>

Proprietary standards have been developed by both individuals and corporations in the private sector and are protected by copyright. Each source utilizes its own standards format. Proprietary standards are available commercially from the vendor.

Sources of some well known facilities maintenance and construction standards and other estimating information resources are listed below:

MAINTENANCE STANDARDS SOURCE	ADDRESS
R.S.Means™ Cost Data Books & Automated Estimating Systems	R.S.Means Company Inc. 100 Construction Plaza P.O. Box 800 Kingston, MA 02364-0800 (617) 747-1270
Walker's™ Building Estimator's Reference Book (and other titles)	Frank R. Walker Company Publishers 5100 Academy Drive Lisle, IL 60532 (312) 971-8989
Construction Criteria Base (CD-ROM)	National Institute of Building Sciences (NIBS) 1201 L Street NW # 400 Washington DC (202) 289-7800
Richardson's™ General Construction Estimating Standards	Richardson Engineering Services, Inc. P.O. Box 9103 Mesa, AZ 85214-9103 (602)497-2062
Estimator's Man Hour Manuals by John S. Page	Gulf Publishing Company Book Division P.O. Box 2608 Houston, Texas 77001 (713)529-4301
Construction Estimating Reference Data (32 other related subject titles)	Craftsman Book Company 6058 Corte del Cedro Carlsbad, CA 92009 (619) 438-7828

The methods used to develop proprietary standards vary among the companies that develop them and are proprietary to the company. On the whole, proprietary standards development firms do not use engineering techniques in their development processes. In many cases, however, it is known that experts are surveyed to determine the time it takes to perform a particular task and the amount of materials and equipment associated with the work.

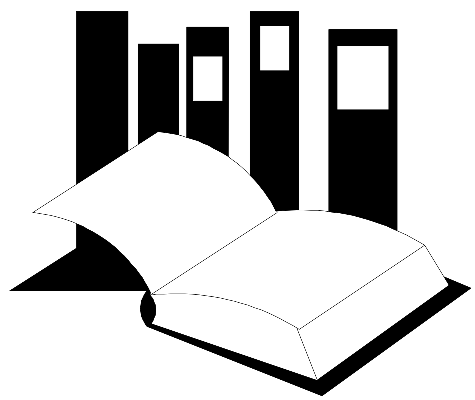
Some hard copy sets of proprietary standards manuals are usually available to the Planner/Estimator. Since these proprietary standards are costly to acquire and keep current, most facilities maintenance organizations chose one vendor or another and purchase one or two sets. The sets are broken up based on the trades in the various volumes and distributed to the Planner/Estimators with the lead responsibility for particular trade estimating.

Some proprietary standards are also available in automated formats including CD-ROM and disk formats. Since cost is a significant factor in acquiring these standards databases and licenses to operate the software, the data , if purchased and installed, may have limited availability for use by all Planner/Estimators.

Some proprietary standards such as R.S.Means™ and Walkers™ are arranged in the Construction Specifications Institute (CSI) master format. CSI is a system of classification and numbering widely used and accepted in the construction industry for estimating. The CSI format contains 20 Divisions as shown below:

CSI Division 1-General Requirements	CSI Division 11-Equipment
CSI Division 2-Site Work	CSI Division 12-Furnishings
CSI Division 3-Concrete	CSI Division 13-Special Construction
CSI Division 4-Masonry	CSI Division 14-Conveying Systems
CSI Division 5-Metals	CSI Division 15-Mechanical
CSI Division 6-Wood and Plastics	CSI Division 16-Electrical
CSI Division 7-Thermal and Moisture Protection	CSI Division 17-Square Foot
CSI Division 8-Doors and Windows	CSI Division 18-Miscellaneous Items
CSI Division 9-Finishes	CSI Division 19-Selective Demolition
CSI Division 10-Specialties	CSI Division 20-Miscellaneous Modification Items

Each CSI Division is broken down to sub-divisions consisting of a five digit identifier starting with the Division number (i.e. 08100 Metal Doors and Frames is a sub-division of CSI Division 8-Doors and Windows.



Most proprietary standards sources are well indexed and easy to use. Vendors generally offer standards application training at centralized training sites throughout the country. The databases are generally updated on a periodic basis because labor rates and material costs change from year to year. It is up to the user organization to ensure that the standards being referenced and applied are current to maintain the accuracy level of the estimate.

In applying any work estimating standards methodology, accuracy is affected by the Planner/Estimator's ability to identify the work requirements and plan the job. Selection of the applicable standard from the choices available, the accuracy of unit requirements and mathematical calculations, the crew composition, and local labor and material cost factors are all an integral part of estimating accuracy.

2. <u>Public Domain Standards.</u>

Standards available in the public domain, in most cases, have been developed either for or by the government and are not protected by copyright. They are available to government agencies and the public at a reasonable (reproduction) cost and in some cases at no cost. Facilities maintenance standards in the public domain include the following:

MAINTENANCE STANDARDS	SOURCE
Engineered Performance Standards (EPS) Inspection Standards	Naval Facilities Engineering Command Industrial Engineering Center Commander, Atlantic Division Naval Facilities Engineering Command ATTN: Code 165 1510 Gilbert Street Norfolk, VA 23511-6287 (804) 322-7701 DSN 262-4701
PAVER, ROOFER, and RAILER and other specialty maintenance and repair work standards	U.S. Army Construction Engineering Research Laboratory P.O. Box 9005 Champaign, IL 61826-9005 (800) USA-CERL
Job Order Contracting (JOC) Standards	U.S. Army Center for Public Works Fort Belvoir, VA 22060-5516 (703) 355-2300

The proponent agencies for many of these public domain standards databases have made the databases and standards updates available to the general public for downloading from electronic bulletin boards. Most of these standards databases are available to Planner/Estimators on personal computers or incorporated into standard automated management information systems such as the U.S. Army Integrated Facilities System - Micro/Mini (IFS-M), the Public Works Management Automation (PWMA) system, the U.S. Air Force Work Information Management System (WIMS), and the Marine Corps Real Property Maintenance/ Family Housing System (RPM/FHS).

Methods of development for public domain standards vary. Engineered Performance Standards are engineered using industrial engineering techniques and developed specifically for facilities maintenance and repair work. The Job Order Contract standards are developed for the Corps of Engineers by the Construction Inspection Institute using R.S Means™ standards and Corps of Engineers unit pricing data. The U.S. Army Construction Engineering Research Laboratory management engineering systems PAVER, RAILER, and ROOFER are constructed so that maintenance and repair estimates are based on each installation's historical maintenance and repair cost data.

Public domain standards are applicable for a variety of types of facilities maintenance and repair estimates. For instance, PAVER is for road maintenance work, EPS is for facilities maintenance, repair, and preventive maintenance work, and JOC is used in contracting for minor maintenance and alteration work.

All public domain standards require application training. The automated versions require both application and software operation training to teach the user how to navigate through the electronic screens. As with all standards, accuracy depends heavily on proper application and sound work planning prior to selecting the standards.

E. SUMMARY

Planner/Estimators have substantial amounts of work estimating information available from a wide variety of sources, the applicability and accuracy of which is equally as varied. However, because facilities maintenance work covers such a broad spectrum of work requirements, a Planner/Estimator may find that a single job requires work estimating information from several sources. It is important that Planner/Estimators are familiar with the available sources and the application techniques that go with them.

CHAPTER V
STANDARDS

In facilities maintenance management, using work estimating standards provides the organization with a number of benefits. Engineered standards, in particular, provide some very specific benefits to a facilities maintenance management organization. These benefits are typical for engineered standards.

A. BENEFITS OF USING STANDARDS

1. Uniformity and Consistency.

Engineered standards are typically developed using a reliable and proven engineered process. Because of this process, and the standard method of application, the data can be uniformly applied with consistent results for labor hour estimates. Generally, standard data can be applied anywhere similar units of work exist.

2. Level of Accuracy.

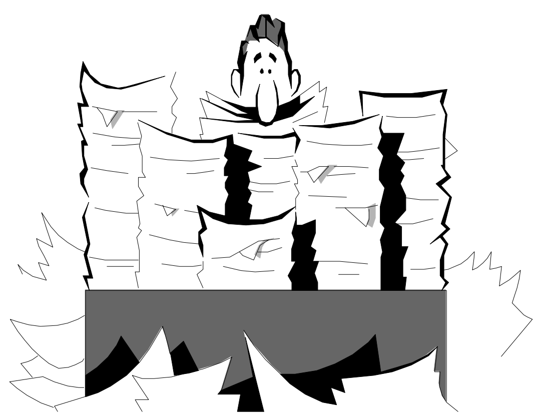
Standard data, as a result of being based on motion time development techniques is as accurate as possible for the work described in the standard. Time associated with maintenance work does not lend itself to having pinpoint accuracy; however, standards estimates increase in accuracy as the scope of work increases.

3. Improved Planning.

Planner/Estimators using standrads must describe the total job by detailing each of the smaller tasks. The result is usually a better job plan which helps coordinate each of the crafts involved setting the stage for proper scheduling and smooth accomplishment of the work.

4. Improved Backlog Management.

Confidence in budget requests for annual and backlogged maintenance and repair funding requirements is gained when standard data is used to develop estimated labor and material costs for maintenance and repair work. To effectively manage backlog, facilities maintenance managers must have an accurate picture of how much backlog work exists. Work estimated using engineered standards most accurately depicts the requirements. It provides a clear picture of potential work shortages or overloads that will subsequently affect productivity. In the event of an audit, estimates developed using engineered standards need no further justification of the estimated cost.



5. Improved Scheduling.

Logically sequenced craft phasing helps the Scheduler to plan each phase of work.

6. Improved Work Accomplishment.

Engineered standards provide craftspersons with adequate amounts of time to perform high quality maintenance and repair work. Standards based estimates also help improve shop performance by allowing the craftspersons to work toward a time goal which they feel is justified and fair.

7. Effective Performance Measurement.

Engineered Performance Standards offer quantifiable benchmarks which can be used to compare actual work accomplishment to estimates. These comparisons help to determine whether work is being accomplished productively. The work accomplishment process can easily be analyzed using work estimates as the basis for measuring productivity and identifying work accomplishment process problems. EPS promotes trend analysis to determine where the work process is breaking down or where innovative improvement ideas are enhancing it and, thus, improving work productivity.

B. TYPES OF STANDARDS

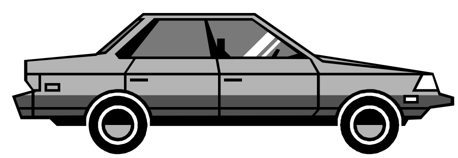
Work processes govern the type of standards required for work estimating. There are maintenance and repair standards for machinery, equipment, vehicles, and facilities; production standards for manufacturing processes such as vehicles, appliances, clothing, etc.; and construction standards for every facet of new construction work. Understanding the differences in these three work processes explains the differences among the three types of standards.

TYPES OF STANDARDS
Production
Construction
Maintenance & Repair

1. Production Standards.

Most production work is repetitive and the work place and methods are normally fixed. The standards applicable to production work normally consist of the following parameters:

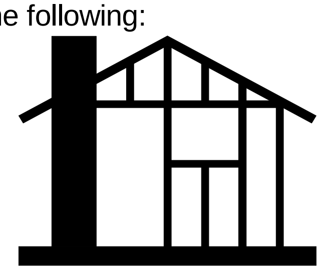
- short periods of time for complete operation
- regimented working conditions (e.g. production line)
- repetitive operation
- exact work methods
- exact work content for each operation
- pinpoint accuracy consistently achievable



2. New Construction Standards.

New construction work is similar to production work in terms of methods of accomplishment and standards. New construction standards normally consist of the following:

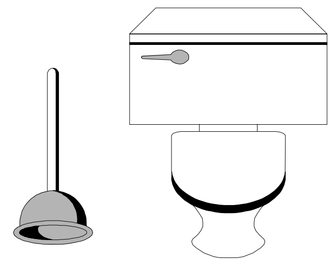
- short to moderate periods of time for complete operation
- minimal working condition impediments
- repetitive operation
- exact method or installation parameters specified in prints and specifications
- exact work content for each operation
- work site prepared for installation
- accuracy based on industry averages and consistently achievable by standard crew



3. <u>Maintenance and Repair Standards.</u>

Unlike production and new construction work in which the working conditions are relatively unobstructed, maintenance work takes place in less than idyllic conditions. Often times, an integral part of a maintenance or repair requirement is the removal or disassembly of existing facility components, machinery, parts, or structures and the subsequent retrofit or rebuilding with new materials or equipment into existing spaces. Standards set for maintenance and repair work normally consist of the following parameters:

- large scope of time required
- restrictive working conditions
- non repetitive tasks
- accepted method(s) not always applicable or useable
- variable work content each time the task is performed
- level of accuracy of the total job time estimate is directly proportionate to the size of the job



C. SELECTING THE RIGHT TYPE OF STANDARD FOR THE JOB

As the parameters for the three types of standards illustrate, using production or construction standards for maintenance and repair work requirements is an inappropriate choice. The differences in the working conditions, the nature of the tasks to be performed, and the broad range of work scope make maintenance and repair work less predictable than construction and production work. However, because maintenance and repair work seems to have a great deal in common with new construction work, a tendency exists to inappropriately apply construction standards to it. Construction standards applied to maintenance and repair work may result in inaccurate maintenance and repair estimates.

When Planner/Estimators understand the differences among the various types of standards, they can begin to be selective in their application of standards to estimates they are required to develop. Combinations of work types frequently arise in alteration type projects. By appropriately combining construction and maintenance and repair standards, the Planner/Estimator can develop well planned estimates that accurately reflect the work requirements of the job and provide sound estimates for planning, scheduling, work accomplishment, and work evaluation within the facilities maintenance management system.

D. ACCURACY

There are differences in the levels of accuracy among the three types of standards. Production standards achieve pin-point accuracy, especially when developed for a production line environment. An established production rate of five pieces per hour is consistently achievable on an hourly basis and should always be achievable on a daily and weekly basis barring breakdowns in the line or supplies to the line.

TIME IS MONEY.

Construction standards have high accuracy levels as well. Trades are scheduled only when the site is ready and prepared for their construction installation phase. There are little or no obstructions to be worked around when the mechanical contractor is called to install ducting for the central HVAC system. Likewise, the crew installing doors and windows finds the building framed out and ready to accept the prefabricated windows and pre-hung doors. Work crews go from point to point doing essentially the same operation with the same work content for each door and window installed.

To develop construction standards, a firm such as R.S. Means™ may develop a construction standard on survey data collected for an average daily output for a carpenter and helper to install 10 average quality, builders' model 2' x 3' double hung windows with insulating glass, including frame, screen and exterior trim. This method for setting standards produce reasonably accurate standards for construction that are accepted throughout the industry.

Figure 5-1 illustrates the accuracy level achievable in the application of production, construction, and maintenance work standards.

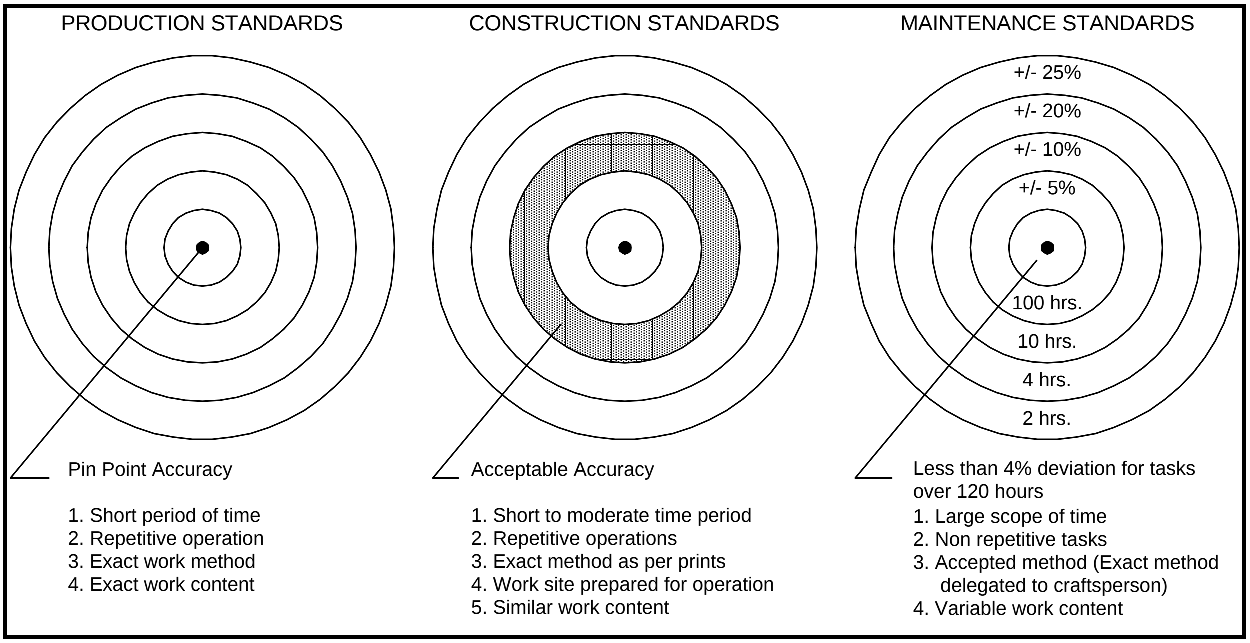


Figure 5-1. Production, Construction, and Maintenance Standards Characteristics

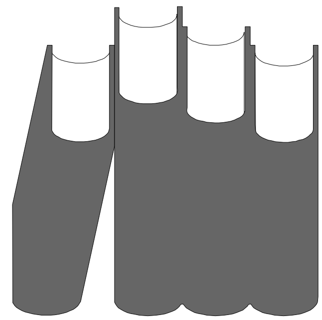
Maintenance standards cannot achieve the accuracy levels of construction and production standards. Although they need to be as accurate as possible, they simply cannot be expected to be exact for each and every job because no two maintenance and repair jobs are exactly alike. In maintenance and repair standard application, the larger the job the more accurate the standards become, whereas, in production and construction standards application, quantity of work has little or no affect on accuracy.

The percentages shown in Figure 5-1 suggest how to consider maintenance standards accuracy. These percentages do not imply an "allowed" error range, nor should they be considered hard and fast guideline percentages. They simply suggest that tasks taking about 2 hours or less to perform may only be accurate to ±25%, tasks taking 10 hours are more accurate at ±10%, and those over 120 hours should only have a margin of error of ±4% estimated to actual time. The more time required for a maintenance or repair job the more accurate the estimate becomes if the standards have been properly applied.

E. SUMMARY

The entire facilities maintenance management organization benefits significantly from the use of standards as a work estimating tool. Improved planning, budgeting, scheduling, work accomplishment, and work evaluation are the results of proper application of standards. Choosing the correct standard type for the work to be estimated and correctly applying the standards from the various sources are the responsibilities of the Planner/Estimator in the organization. Therefore, it is essential the each Planner/Estimator understand the differences among the types of work and learn how to select appropriate standards for the estimates to be developed.

CHAPTER VI
ENGINEERED PERFORMANCE STANDARDS BACKGROUND

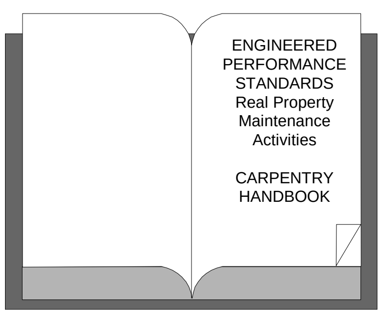


Engineered Performance Standards (EPS) is one of many sources of facilities maintenance and repair standards. Developed by the Department of Defense for use by the Department of Defense, it is the only source of facilities maintenance and repair standards that is designed specifically for maintenance and repair work.

A. THE HISTORY OF EPS

In the early 1950s, the Department of Defense (DOD) became concerned about managing real property maintenance activities. All the services faced a growing problem of maintaining an ever increasing inventory of facilities (many of which were World War II vintage) being utilized far beyond their original designed life capacity. Where breakdown maintenance had been the operating policy, the new direction was to raise the level of maintenance so that these facilities could continue to be utilized. However, no additional resources were provided. In the meantime, accelerated new construction programs continually added more maintenance and repair requirements as permanent facilities were completed and turned over to the Government.

To realize the fullest and most efficient utilization of available resources, industrial engineering procedures and techniques were applied and maintenance management systems developed. Within its framework came the idea of developing standards for maintenance work. This effort beginning in 1957, formed the basis for the Navy's system. Several years later the Army and Air Force, who had been developing standards of their own, adopted the Navy's more advanced Engineered Performance Standards program for estimating maintenance work.



In the early 1970s, standards application within each Department of Defense component varied depending on local command interest or knowledge. In 1976, a memorandum from the Office of the Assistant Secretary of defense established the Department of Defense policy for increased effective use of EPS in RPMA within available resources. The Navy was designated as the lead service to revise, update, and maintain EPS. The Army, navy, Air Force, Marine Corps, and Defense logistics Agency were tasked to provide annual EPS support funds.

The Naval Facilities Engineering Command (NAVFAC) Industrial Engineering Center (NIEC) was established in February 1977. The NIEC's mission was to provide Department of Defense with RPMA standard time data based on the latest work methods. It was also charged to maintain and keep current the EPS standards manuals, training manuals, databases, and application procedures. In subsequent years, as automated systems have been developed to facilitate EPS application and integrate the estimates into standard management information systems that support facilities maintenance management systems, the NIEC was given the added technical responsibility for ensuring that automated estimating systems contain the most updated standards and that they are correctly applied.

B. EPS DEFINITION

Engineered Performance Standards are facilities maintenance and repair standards that have been developed by engineers using proven industrial engineering techniques. Many years of experience and expertise have gone into the derivation of these standards to make sure that they are applicable for maintenance programs. Unlike many other standards, they are developed based on the actual observation of maintenance workers performing the work.

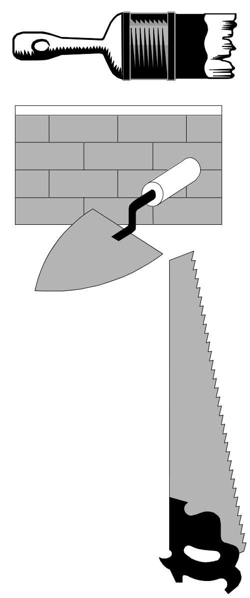
ENGINEERED PERFORMANCE STANDARD

The ***average*** *time necessary for a* ***qualified*** *worker, working at a* ***normal pace,*** *under* ***capable supervision*** *and experiencing* ***normal delays****, to perform a* ***defined amount of work****, of a* ***specified quality****, while following* ***acceptable trade methods.***

Each standard represents the amount of time it **should** take under normal work conditions to perform a given amount of work. Obviously, the terms *normal, average,* and *qualified* mean different things to different people, but EPS has been developed based on conditions which represent the norm.

EPS data is a tool used by Planner/Estimators to develop consistent, uniform, and accurate facilities maintenance and repair estimates. Any trained Planner/Estimator who has a working knowledge of craft work should be able to develop good labor hour estimates using these standards. Then, as discussed in previous chapters, the work estimates can be used to support various functions within the facilities maintenance management system.

C. ADVANTAGES OF EPS



1. Design.

Engineered Performance Standards are designed specifically for facilities maintenance type work through the observation of maintenance workers at work. The work is measured through the use of proven industrial engineering techniques such as Methods-Time Measurement (MTM), work sampling, and time studies. They are designed to relate a given amount of work to the labor hours needed to accomplish the work.

2. Transferability.

EPS estimates are based on the labor hours needed to do a specified amount of work under normal conditions. When EPS is properly applied under those normal conditions, the craft time should be valid at any work site in any geographical location.

3. Productivity Measurement.

EPS is the only facilities maintenance work estimating source that provides consistent measures of maintenance work productivity. As a benchmark EPS provides a means of measuring productivity. The variance between EPS estimates and the actual labor times can be evaluated to identify work process problems impeding both the productivity of the work force and the quality of the work output.

4. Accuracy.

Facilities maintenance work does not lend itself to having pinpoint accuracy for any particular single job or task. Rather, the accuracy of EPS based estimates increases as the size of the job increases and the effect of averaging levels the variables stated in the EPS definition: normal pace, capable supervision, normal delays, and acceptable trade methods.

5. <u>Practicality</u>.

Engineered Performance Standards are developed and consistently applied so that Planner/Estimators can estimate a greater variety of jobs with increased accuracy, in less time, and with less formal data than using conventional data. All EPS data is applied in the same way.

D. EPS DEVELOPMENT

Three proven industrial engineering techniques form the basis of EPS development.

1. <u>Methods Time Measurement (MTM)</u>.

TMU
One Time Measurement Unit = 0.00001 Hours

MTM is a system of predetermined time standards which provides a precise measuring method for human motions. It was developed and is maintained by the MTM Association in Fair Lawn, New Jersey. Using video tapes of maintenance craftspersons performing a specific work task, a detailed analysis of each motion is made to determine every element associated with the work operations being performed. The exact time of basic motions used to accomplish work is measured in Time Measurement Units (TMU). These basic time elements are universal and can be used to develop a time standard for almost any work requiring hand, body, or eye motions such as reach, grasp, move, position, release, etc.

2. <u>Time Study</u>.

Time study or stopwatch observations are used in EPS development to determine the amount of time for elements not fully controlled by workers. For example, machine time to fabricate an item, filling a tank, or driving a piling are all dependent upon the speed of the equipment used in conjunction with the accomplishment of the work. Time study is also used to validate the reasonableness of the overall times developed by other techniques. In addition, time studies are used as the basis for developing Travel Zone Maps used by the Planner/Estimator to apply round trip travel to and from the work site. (See Appendix D for details on Travel Zone Map development.)

3. <u>Work Sampling</u>.

Work sampling is an industrial engineering technique used primarily in EPS to determine the percentages of work or delays associated with EPS allowances such as job preparation and craft allowances. Work sampling is the observation of a worker during a specified time range such as a shift, a work day, or at random intervals over longer periods of time. At specified intervals, the observer notes the worker’s specific activity. Numerous work sampling observations by trained observers result in very high statistical confidence in the percentages of work and associated delays experienced by craftspersons.

E. ENGINEERED PERFORMANCE STANDARDS

Through the application of MTM, Engineered Performance Standards are built based on the observation of work being performed. For illustration purposes, Figure 6-1 illustrates the EPS task development process.

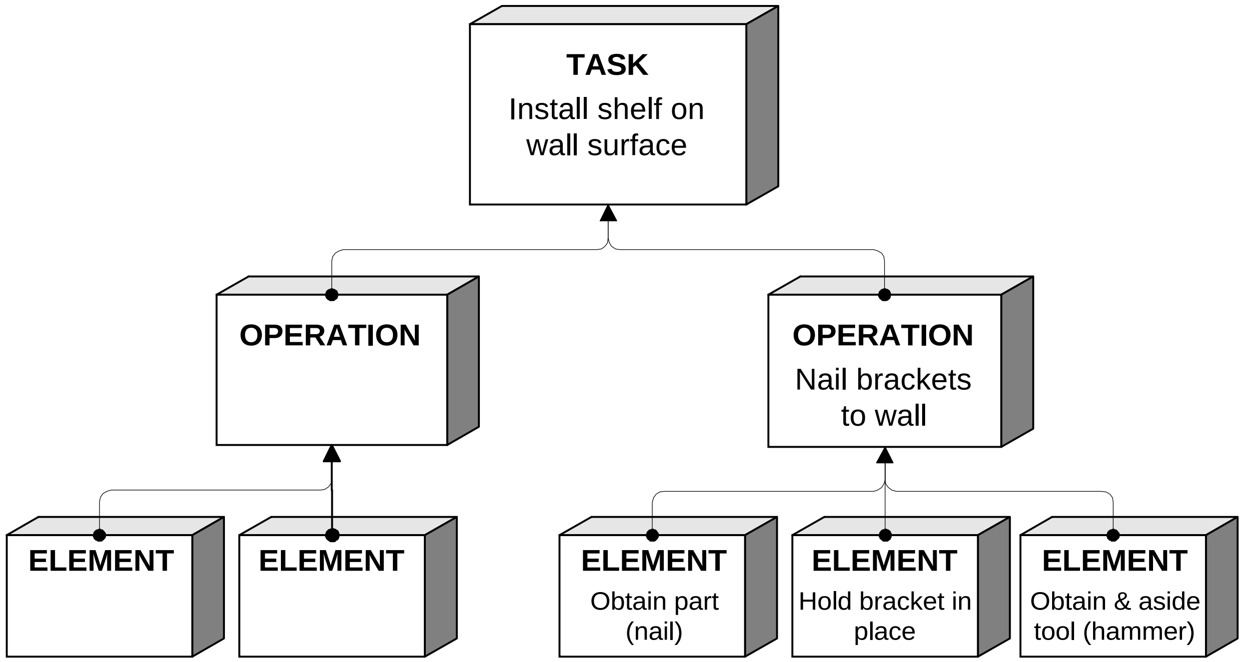


Figure 6-1. EPS Task Development

1. <u>EPS Element</u>.

EPS elements are the smallest work unit in a standard. EPS elements are a composition of basic motions and/or machine or process activities that are distinct, describable, and measurable. For example, the EPS element *OBTAIN AND ASIDE TOOL* combines several basic MTM elements (e.g. reach, grasp, move, position, release).

2. <u>EPS Operation</u>.

An EPS operation is a series of related EPS elements performed by workers that results in a desirable change in location or condition of maintenance materials or parts. For example, to obtain a hammer, hold a bracket, drive a nail, and aside the hammer could constitute an EPS operation.

3. <u>EPS Task</u>.

An EPS task is a combination of operations that result in a specific amount of work that can be performed by a single craft with a specified time required to accomplish it. Each task time standard (TTS) shows the labor hours required to perform the work described and is used as a basis for information presented in the EPS craft handbooks. An example of an EPS task is to *INSTALL A SHELF*. It consists of the operations of measuring the wall, handling material, positioning the shelf and brackets to the wall, nailing the brackets to the wall, and positioning the shelf on the brackets.

F. EPS BUILDING BLOCKS OF TIME

Work estimates in which EPS is properly applied are actually developed by assembling "blocks of time". These blocks of time include craft task requirements (Craft Data), task requirements used by all crafts (Universal Data) and job preparation, craft delay allowances, and travel time (General Data). Each of these blocks is needed to arrive at the total Allowed Job Time for the job. Figure 6-2 shows the blocks of time that make up a complete EPS estimate.

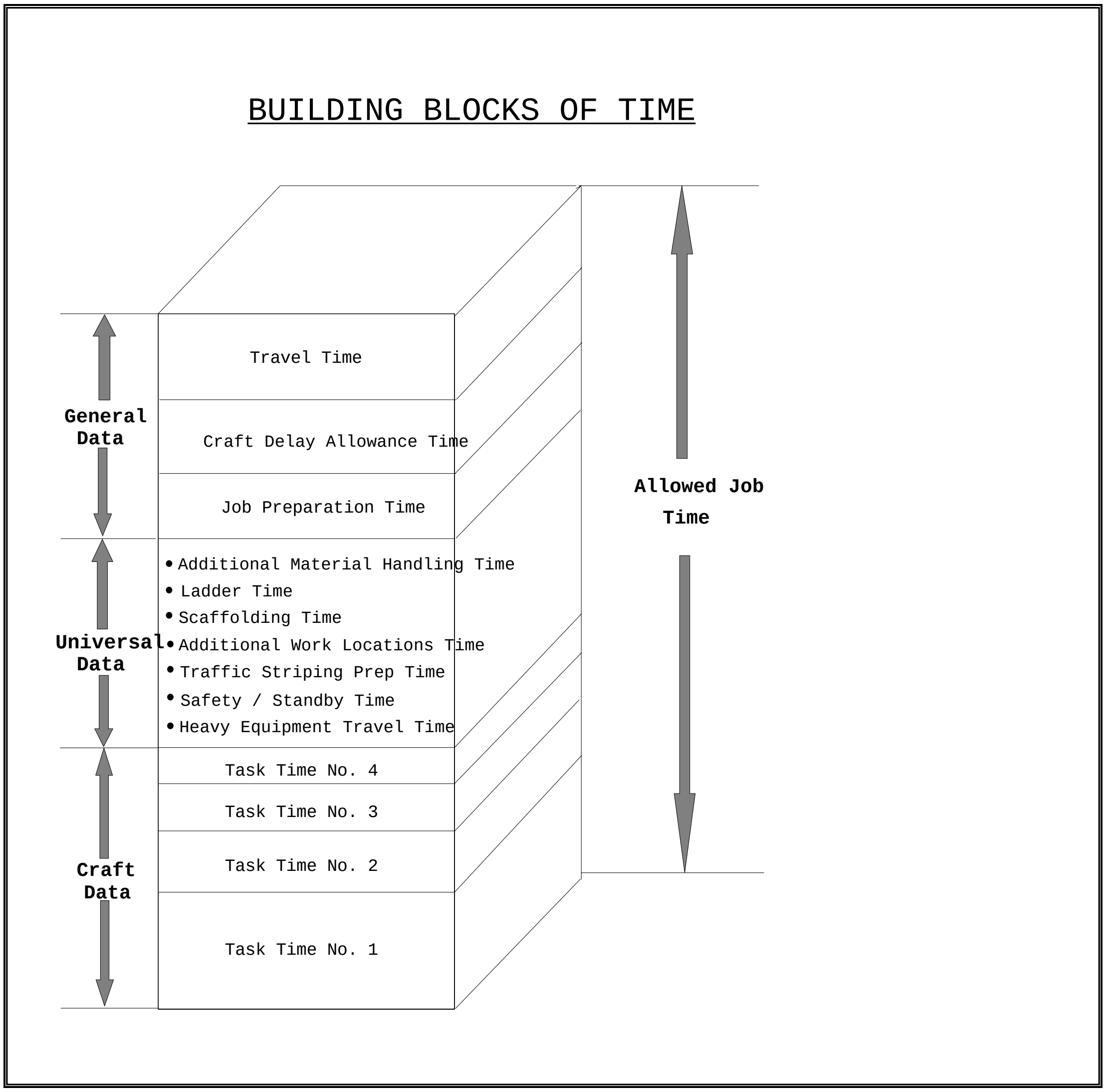


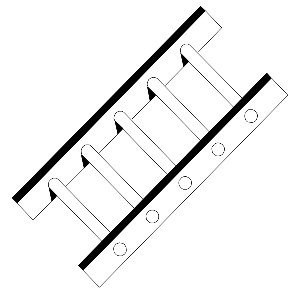
Figure 6-2. EPS Estimate Building Blocks of Time

1. Craft Data.

Craft data includes all craft related task times derived from Engineered Performance Standards.

2. Universal Data.

Universal Data is Engineered Performance Standards task time applicable to all crafts. It includes:



a. Additional Material Handling (AMH). Time allowed to move materials from one location to another.

b. Ladder Time. Time allowed to use a ladder in performing a task.

c. Scaffolding Time. Time allowed to assemble *or* disassemble, move, raise, and lower scaffolding based on the number of scaffold sections required for the job.

d. Traffic Striping Machine Time. Time allowed at the end of each day to clean the paint striping machine during road marking jobs.

e. Standby/Safety Time. Time allowed for a safety person or standby person in support of the craftsperson(s) performing the task.

f. Additional Work Location (AWL). Time allowed for craftspersons to move to different locations either within a facility, between facilities, or within the same travel sector.

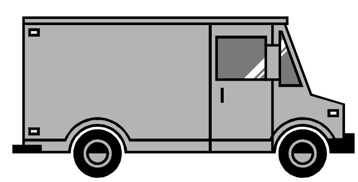
g. Heavy Equipment Travel (HET). Additional travel time allowed for heavy or large equipment which normally travel at below normal speeds.

3. General Data.

The general data provides the time required for:

a. Job Preparation. Time to get ready for the job and time to "finish up" after the craft work has been completed.

b. Craft Delay Allowances. A percentage of craft time that either supports the accomplishment of the job or is an unavoidable delay that is an inherent part of facilities maintenance repair work and cannot be avoided. It includes planning, balancing delays, personal time, and unavoidable delays.



c. Travel. One round trip, per craftsperson per day between the shop and the job site.

Each of the building blocks of time is discussed in detail in Chapter VII. The EPS techniques associated with applying these building blocks of time to develop and estimate are presented in Chapters 8, 10, and 11.

CHAPTER VII
EPS APPLICATION

EPS offers the only standards database developed specifically for facilities maintenance and repair work. The EPS database contains approximately 3400 task time standards. EPS should be the first source of standards considered in developing a facilities maintenance work estimate.

A. ENGINEERED PERFORMANCE STANDARDS FORMAT

EPS tasks are divided into craft area standards, preventive maintenance/recurring maintenance (PM/RM) standards, and service standards. The EPS handbooks are numbered and the craft areas identified by two or three letter designators. Figure 7-1 provides a listing of the handbooks and associated craft designators.

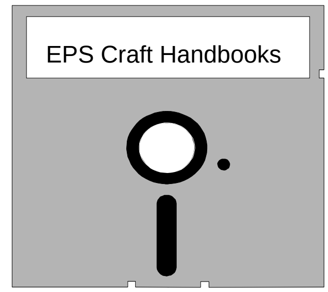
HANDBOOK NUMBER	CRAFT	CRAFT DESIGNATOR
01	General	
02	Carpentry	CT
03	Electric, Electronic	GT
04	Heating, Cooling, Ventilation	VT
05	Janitorial	JT
06	Machine Shop, Machine Repairs	
	Machine Shop	MT
	Machine Repair	NT
07	Masonry	DT
08	Moving, Rigging	BT
09	Paint	PT
10	Pipefitting, Plumbing	QT
11	Roads, Grounds, Pest Control & Refuse Collection	
	Roads	WT
	Grounds	RT
	Pest Control	QAT
	Refuse Collection	ST
12	Sheetmetal, Structural Iron & Welding	
	Sheetmetal	LAT
13	Structural Iron & Welding	EAT
14	Trackage	ZAT
	Wharfbuilding	ZT
	Preventive Maintenance/Recurring Maintenance	
	Service	

Figure 7-1. Craft Handbook Table

The PM/RM and Service standards do not have task identifiers. For PM/RM, operations are used to build estimates (see Chapter 11). For Service standards, four digit identifiers are used.

EPS data is presented in two formats:

- automated work estimating databases
- craft handbook printing program



Most Planner/Estimators use automated work estimating programs in a sophisticated computer maintenance management information system (CMMIS). The EPS database may be the only standards database or one of many contained in the system. Some Planner/Estimators develop estimates manually. The NIEC has downloaded the EPS database into a floppy disk craft handbook printing program. Text files of each handbook can be generated, allowing hardcopy users to print a set of craft handbooks using a variety of word processing programs.

1. <u>Handbook Table of Contents.</u>

In either the automated or the printed versions of the EPS database, each craft handbook has a table of contents. Figure 7-2 is a sample of the Carpentry Handbook Table of Contents. The numbered areas in Figure 7-2 provide the following information about the contents of the handbook:

1 Book Number: Craft Handbook number (see Figure 7-1)
2 Chapter Number: Numeric division of craft task areas in the handbook
3 Description: Description of the chapter content

2. <u>Chapter Table of Contents.</u>

Each handbook chapter has a table of contents which lists the task time standards (TTS) in the chapter. Figure 7-3 is a sample chapter table of contents page. The numbered areas on the figure provide the following information about the chapter content:

1 Book Number
2 Chapter Number
3 Short Chapter Description: Short description of chapter content taken from the Handbook table of contents
4 General Chapter Description: General information about the task time standards in the chapter and notes related to task performance
5 Task Time Standards: List of the task time standards contained in the chapter
6 Task Time Standard Reference: EPS TTS Reference number which consists of the craft designator (see Figure 7-1) and a three digit identification number
7 Task Time Standard Description: Brief description of the task time standard

3. <u>Task Time Standard List.</u>

Following the chapter table of contents each task time standard is listed by TTS reference. A detailed description of the task is given and the unit hours to perform the task are provided. Figure 7-4 provides a sample Task Time Standard List page. The numbered areas in Figure 7-4 provide the following information about the task time standards.

1 Book Number
2 Chapter Number
3 Page Title: EPS Task Time Standards - Descriptions and Unit Hours
4 Task Time Standard Reference
5 Task Time Standard Description: Detailed description of the specific amount of work contained in the task time standard
6 Task Time Standard Hours: The amount of craft time required to perform the specific amount of work contained in the task time standard

TABLE OF CONTENTS BOOK 02 *1*

CHAPTER *2*		DESCRIPTION *3*	
010	CARPET :	Tiles and Roll	(Remove,Install,Replace,Cut)
020	CEILINGS/TRIM :	Fiberboard	(Remove,Install,Replace,Repair
030	CEILINGS :	Acoustical tile	(Remove,Install,Replace,Repair
040	CEILINGS :	Suspended	(Install,Replace)
050	CEILINGS :	Sheetrock	(Install)
060	DOORS/HARDWARE:	Standard door	(Remove,Install,Replace)
070	DOORS/HARDWARE:	Screen-(wood) Storm-(aluminum)	(Remove,Install,Replace) (Remove,Install,Replace)
080	DOORS/HARDWARE:	Roll Up Type -	(Remove,Install,Assemble & Replace)
090	EXTERIOR CARPENTRY:	Various Items	(Remove,Repair,Replace)
100	EXTERIOR TRIM WORK:	Fascia Board	(Remove,Install,Replace)
110	FENCES:		(Remove,Repair,Replace Assemble&Install)
120	FLOORS:	Floor Covering	(Remove,Install,Prepare Floor)
130	FLOORS:	Floor Covering	(Replace)
140	FLOORS:	Hardwood Floors	(Remove,Install,Replace)
150	FLOORS:	Sanding	(Resurface)
160	FORMS:	Box, Manhole or Deck	(Fabricate&Install,Remove)

Figure 7-2. Sample Handbook Table of Contents (Carpentry)

```
BOOK NUMBER  02  1           CHAPTER NUMBER   060  2             PAGE        12
 DOORS/HARDWARE: 3  Standard door    (Remove,Install,Replace      )
  ____________________________________________________________________
 :  4                                                                       :
 :  DOORS/HARDWARE:   Remove, Install, Replace                          :
 :  DOORS        :   Interior/Exterior doors- wood & sliding            :
 :  HARDWARE     :   Aluminum threshold, astragal, door casing,         :
 :                   door closer, hinge butts, jambs and trim,          :
 :                   locks,panic hardware, weather stripping.           :
 :                                                                      :
 :______________________________________________________________________:

                        TASK TIME STANDARDS LISTING  5
   6         7
 CT 601   DOOR:          (Remove)                         3 hinge pins
 CT 029   DOOR:          (Install)                        3 hinge pins
 CT 043   INTERIOR DOOR: (Install) cut-in wall, frame   w/hydraulic check.
 CT 041   INTERIOR DOOR: (Install) cut-in wall, frame   w/hydraulic check,
                                                             tubular lock.
 CT 042   INTERIOR DOOR: (Install) pre-hung unit,      w/factory installed
                                   cut-in wall, frame        hardware.
 CT 044   INTERIOR DOOR:  (Install) door & aluminum frame on movable
                                                   laminated partition.
 CT 045   INTERIOR DOOR:  (Install) door on already framed & cased opening
                                        w/ hydraulic check & tubular lock.
 CT 040   EXTERIOR DOOR:  (Install) cut-in, frame       w/hydraulic check
                                                          & mortise lock.
 CT 048   EXTERIOR DOOR:  (Install)  in previously framed & cased opening,
                                        w/ tubular lock.
 CT 046   EXTERIOR DOOR:  (Install)  in previously framed & cased opening,
                                        w/ hydraulic check & tubular lock.
 CT 598   EXTERIOR DOOR:  (Replace)  door w/ cylinder lock
 CT 047   SLIDING DOORS:  (Install)  12'x9' high double sliding doors, w/
                                                                brackets.
 CT 039   DOOR FRAME:     (Install) cut-in wall, frame       interior door
                                                                 opening.
 CT 027   DOOR CASING:    (Install) one side.
 CT 028   DOOR CASING:    (Replace) one side.
 CT 030   WOOD DOOR:      (Repair)                  trim bottom to fit
                                                    threshold 1/4" or more.
 CT 031   METAL DOOR STOP:(Install) hook type,      w/ expansion shields in
                                                                concrete.
 CT 600   HYDRAULIC DOOR CLOSER: (Install)
 CT 599   HYDRAULIC DOOR CLOSER: (Replace)
 CT 037   WEATHER STRIPPING: (Replace)          around door.
 CT 603   HINGE BUTT:        (Remove)           three hinge butts from door
 CT 602   HINGE BUTT:        (Remove)           three hinge butts from door
                                                               & jamb.
 CT 711   PANIC BAR:         (Install)          with lock set on metal door
 CT 032   PANIC HARDWARE:    (Install)          exit bolts on single door.
```

Figure 7-3. Sample Chapter Table of Contents (Carpentry)

NUMBER 02 1 CHAPTER NUMBER 060 2 PAGE 14

3 EPS TASK TIME STANDARDS - DESCRIPTIONS AND UNIT HOURS

4 5

CT 044 Door (interior), install with aluminum frame on movable laminated partition wall. Hardware on door, frames factory cut for 36"w x 84"h door.

6 002.77740 hours per interior doors to install

CT 045 Door, interior (32"-36" x 6'-8"), install in previously framed and cased opening. Includes installation of hydraulic door check and tubular lock.

002.55600 hours per interior doors to install

CT 040 Door (exterior), cut in, fame, install jamb, casing trim, hang, install hydraulic door check and mortise lock - when exterior sheathing is 3/8" corrugated asbestos siding and interior is 1" x 12" board and batten (or equivalent). Per door.

008.92973 hours per exterior doors to install

CT 048 Door, interior, 32"-36" x 6'8", hang in previously framed and cased opening, install tubular lock.

002.24046 hours per interior doors to hang

CT 046 Doors, exterior, 32"-36" x 6'8", install in previously framed and cased opening. Includes hydraulic door closer and tubular lock.

003.37129 hours per doors to hang

CT 598 Door (exterior), remove old and install new (36" x 78") with cylinder lock.

001.74130 hours per exterior doors to replace

CT 047 Door, double straight sliding, install on frame building; trolley brackets 2' O.C. opening, 12' wide, 9' high.

003.99833 hours per sliding doors to hang

Figure 7-4. Sample Handbook Task Time Standard List (Carpentry)

4. <u>Standards Development Backup Page.</u>

Figure 7-5 is a sample Standards Development Backup page from the Carpentry Handbook. Each page of standards development backup data contains a sequential list of the task time standards by reference number contained in the chapters of the handbook. Next to the reference number is a list of the component operations of the task time standard. The numbered areas on Figure 7-5 contain the following information:

1 Task Time Standard Reference
2 Component Operations: List of the component operations of the task time standard

```
          TASK TIME STANDARDS DEVELOPMENT BACKUP          PAGE   6
 1               2
CT   594  1 SECURE SMALL SIZE CONTAINER WITH METAL BANDING.
            USE COMBINATION STRAPPING TOOL.

CT   595  1 SECURE MEDIUM SIZE CONTAINER WITH METAL BANDING.
            USE COMBINATION STRAPPING TOOL.

CT   596  1 SECURE MEDIUM SIZE CONTAINER WITH METAL BANDING.
            USE STRAP DISPENSER, PULLER, CRIMPER, AND CUTTER.

CT   597  1 SECURE LARGE SIZE CONTAINER WITH METAL BANDING.
            USE STRAP DISPENSER, PULLER, CRIMPER, AND CUTTER.

CT   598  1 REMOVE DOOR AND SET ASIDE
          2 LAYOUT AND CUT NEW DOOR TO SIZE
          3 REMOVE HINGE BUTTS FROM OLD DOOR
          4 INSTALL HINGE BUTTS ON NEW DOOR
          5 INSTALL DOOR WITH HINGE PINS.  PLANE AND SAND TO
            FIT
          6 INSTALL CYLINDER LOCK TO NEW DOOR (INCLUDES STRIKE
            PLATE)
          7 MATERIAL HANDLING

CT   599  1 REMOVE HYDRAULIC DOOR CLOSER
          2 INSTALL HYDRAULIC DOOR CLOSER
          3 MATERIAL HANDLING

CT   600  1 INSTALL HYDRAULIC DOOR CLOSER.

CT   601  1 OBTAIN TOOL OR PART AND PUT AWAY (BELOW KNEE
            LEVEL)
          2 REMOVE THREE (3) HINGE PINS
          3 ASIDE DOOR - MATERIAL HANDLING
```

Figure 7-5. Sample Standards Development Backup Page (Carpentry)

B. EPS TASK CONCEPTS

To apply EPS task time standards correctly a Planner/Estimator needs to learn the basic EPS application concepts.

1. Occurrence.

In EPS the number of task occurrences is a factor of the amount of work in the task being estimated divided by the amount of work in the EPS task to which it is being compared.

EXAMPLE

REQUIRED WORK:

Cut, assemble, install, and test for leaks 50 LF of 2½" plastic pipe.

EPS TASK QT 237:

Pipefitting, Plumbing

Cut, assemble, install, and test for leaks a section of plastic pipe. Up to 3" ID section, one joint. (Includes) Cut, assemble, and install section of pipe. Move tools and materials. Inspect joint.

TASK TIME:

0.27221 hours per *20' section* of plastic pipe to install.

OCCURRENCE:

$$\frac{\text{Task Requirement}}{\text{EPS Task Requirement}} = \text{Occurrence}$$

$$\frac{\text{50 LF}}{\text{20 LF}} = \text{2.5 Occurrences}$$

CRAFT TIME:

0.27221 x 2.5 Occurrences = 0.681 hours

2. Job Setup/Piece Time.

Job setup time is a task time requirement per job or work location within a task time standard. It is used to account for machine setup or worksite preparation. Piece time is provided for the accomplishment of operations associated with items or pieces to be produced.

EXAMPLES

REQUIRED TASK:

Fabricate 20 duct hangers.

EPS TASK LAT 040:

Sheetmetal, Structural Iron, & Welding

Fabricate rectangular duct hanger from 11 gauge bar stock. Includes: shear flat bar, punch 3 holes in hanger, bend hangers, material handling.

EXAMPLES (cont.)

TASK TIME:

0.09813 hours per JOB SETUP TIME

0.06502 hours per hanger to fabricate

CRAFT TIME:

0.09813 x 1 Job = 0.099 hours
0.06502 x 20 hangers = 1.301 hours
0.099 + 1.301 = 1.4 hours craft time

***

REQUIRED WORK:

Install 200 square feet of 12" X 12" acoustical tile ceiling using ladder (100 square feet in Room 210 and 100 square feet in Room 204).

EPS TASK CT 009:

Carpentry
Ceiling, 12" X 12" acoustical tiles, install. No moulding. Use ladder or scaffold.

TASK TIME:

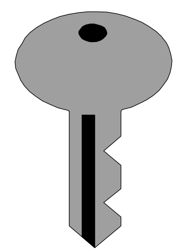
000.08280 hours per JOB SETUP TIME
000.01728 hours per square foot

CRAFT TIME:

0.08280 x 2 Jobs = 0.166 hours
0.01728 x 200 square feet = 3.456 hours
0.166 + 3.456 = 3.622 craft hours

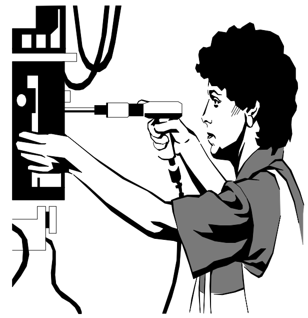
3. Craftbook Key Terms.

EPS data contains a technical vocabulary of terms that the P/E should know to identify the most appropriate standard for the work requirement. Within the craft areas, the task descriptions in a particular chapter may appear to be similar. The only difference may be a single word. However, that word is key to the task supported by the standard. Knowing what key words to look for makes selecting the correct standard easier.



KEY WORD	EPS APPLICATION
Install	To fix in position materials, parts, equipment, or fabricated items
Remove	To take, extract, or separate materials, parts, equipment, or fabricated items from a fixed position
Replace	To remove and install materials, parts, equipment, or fabricated items in a fixed position
Remove & Install	Same as *Replace*

KEY WORD	EPS APPLICATION
Fabricate	To create a part, piece, or item to be installed
and (&)/or	Standards frequently contain the words *and* or *or*. Care must be taken reading each standard to determine what is being stated, e.g. load *or* unload means to do one or the other while load *and* unload means to do both.



There is a significant difference in task time between an install process and a replace process. When the Planner/Estimator selects an install standard the craftsman will have sufficient time to install the item but no time to remove the old item before installation. If the work is actually to replace something, the estimate is inaccurate. The same type of craft time shortage occurs when *and* and *or* are misused. For example, in the General Handbook, the standard P 701A is to assemble *or* disassemble scaffolding. If a work crew must do both in conjunction with other tasks, one occurrence of this standard will not provide sufficient time for both scaffolding requirements.

4. <u>Work Content Comparison</u>.

When the exact work content of a task is not clear from the task description, the Planner/Estimator can look at the operations for the task in the Task Time Standards Development Backup to get a better idea of the work to be performed in conjunction with the standard. By comparing the work in the work requirement to be estimated and the work in the standard, the experienced Planner/Estimator can determine if the operations are comparable and the standard applicable to the work requirement.

EXAMPLE #1

REQUIRED TASK:

Cut an opening in an existing wall of a frame building and frame the opening for a 3'2" x 5'10" jalousie window.

EPS TASK CT 161:

Carpentry

In the craft area there is no task that exactly matches the required task. However, there is a task for "Framework, window, double hung, 3'6" x 6'0", cut in and rough frame opening in exterior wall of frame building.

TASK TIME:

0.04234 hours per JOB SETUP TIME

3.25831 hours per opening to frame

EPS STANDARDS DEVELOPMENT BACKUP:

CT 161 is comprised of the following operations:

EXAMPLE #1 (cont.)

1 Remove moulding and baseboard
2 Measure, mark, and saw interior fiber wallboard
3 Cut outside wall siding and diagonal sheathing
4 Remove outside wall siding and sheathing
5 Cut out studs for window opening
6 Saw studs for side framing header and sub-sill
7 Insulate joint with 15# felt
8 Position rough framing lumber
9 Nail rough framing lumber
10 Measure and mark fiberboard for wall patch
11 Install fiberboard on walls
12 Install baseboard
13 Install shoe moulding (no mitering)
14 Move, climb up and down ladder
15 Material handling

A review of the CT 161 operations shows that the same operations are required for the for both window installations. The fact that the size of the window is slightly smaller than the EPS task does not affect the operations or the time to perform the work.

CRAFT TIME:

0.04234 x 1 Job = 0.043 hours
3.25831 x 1 Window = 3.259 hours
0.043 + 3.259 = 3.302 hours craft time

EXAMPLE #2

REQUIRED TASK:

Install fire alarm pull station on plaster wall. Cable has been previously installed.

EPS TASK GT 027:

Electric, Electronic
No task for installing a fire alarm pull station exists in EPS. A task for installing a thermostat to a plaster wall surface can be considered comparable.

TASK TIME:

0.30202 hours per thermostat

EPS STANDARDS DEVELOPMENT BACKUP:

GT 027 is comprised of the following operations:

1 Unpack control
2 Remove cover plate (one screw)
3 Fasten base to wood surface (two screws)

EXAMPLE #2 (cont.)

4 Cut and form leads, insert in base hole and connect to terminals (three wires)
5 Set thermostat adjustment
6 Install cover plate (one screw)
7 Walk to equipment power source controls and return (avg. 20 paces each way)
8 Turn control switch on and off
9 Check operation

CRAFT TIME:
0.30202 hours x 1 pull station = 0.303 hours craft time

5. Craft Time Adjustment (CTA).

EPS application includes a Craft Time Adjustment factor which may be used to slightly modify EPS task time standards so that they can be applied to a wider range of work requirements. The CTA is used only when work content comparison indicates that the required work has slightly more or less actual work than the EPS task, but cannot easily be added as a separate task.

Figure 7-6 provides a chart of the Craft Time Adjustment hours. The chart is based on the total hours for the task. After the task time standard hours have been multiplied by the number of occurrences, the craft time may be adjusted either up or down based on the CTA limits in the chart. The adjustment is *down* if the work content comparison reveals that slightly less work is required and *up* if slightly more work is required.

CRAFT TIME ADJUSTMENT (CTA) CHART							
EPS CRAFT TIME		**CTA HOURS**		**EPS CRAFT TIME**		**CTA HOURS**	
FROM	**UP TO, BUT NOT INCLUDING**	**LIMIT LOW**	**VALUE HIGH**	**FROM**	**UP TO, BUT NOT INCLUDING**	**LIMIT LOW**	**VALUE HIGH**
0.0	0.2	0.0	0.3	9.0	11.0	8.0	12.5
0.2	0.4	0.1	0.6	11.0	14.0	10.0	16.0
0.4	0.8	0.3	1.1	14.0	18.0	12.5	20.0
0.8	1.4	0.6	1.8	18.0	22.0	16.0	24.0
1.4	2.2	1.1	2.9	22.0	26.0	20.0	29.0
2.2	3.6	1.8	4.4	26.0	32.0	24.0	36.0
3.6	5.2	2.9	6.0	32.0	40.0	29.0	45.0
5.2	7.0	4.4	8.0	40.0	UP	36.0	+10 hrs
7.0	9.0	6.0	10.0				

Figure 7-6. Craft Time Adjustment

EXAMPLE

REQUIRED WORK:
Install 10 separate fluorescent troffer light fixtures in suspended ceiling. Wire 2 motion sensors in ceiling, each controlling 5 lights.

EPS TASK GT 616:
Electrical
Install recessed fluorescent light (troffer) fixtures in suspended ceiling - 2 fixtures per job.

TASK TIME:
10 fixtures x 1.33373 hrs per 2 fixtures = 6.669 hrs
GT 616 involves the same basic procedure as the required work; however, some additional work is required to wire in the motion sensors.

CRAFT TIME:
From Figure 7-6, EPS craft time between 5.2 hours and 7.0 hours has an associated Craft Time Adjustment limit from 4.4 to 8.0 hours The estimator may then adjust the craft time any amount from 6.669 up to 8.0 hours.

C. NON-EPS TASKS

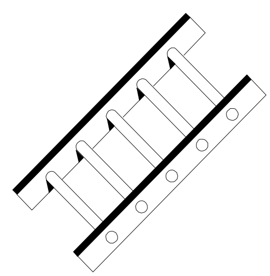
When EPS is used as the primary standard source for developing facilities maintenance and repair estimates, all other sources of standards (proprietary and public domain) and other categories of estimating information are considered *Non-EPS*.

D. UNIVERSAL DATA

The EPS General Handbook contains Universal Data that is common to all crafts. Universal Data includes the tasks listed below.

1. <u>Ladder Time (PWP-009)</u>.

When a ladder is needed to perform the task, but the task time standard does not include ladder use in the task operations, there are four types of ladder time. Before adding ladder time, the operations in a task time standard should be reviewed to be sure ladder time is not included in the task itself. In this way, adding additional ladder time when it is not needed can be avoided. Figure 7-7 provides a chart of the ladder time standards.



a. To Reach Objects Per Move (PWP-009A thru E). Use when each object to be worked on requires the ladder be positioned for the craftsperson to climb up and down then moved aside. Occurrences are based on the number of objects to be reached.

EXAMPLES
- ***Changing light bulbs in ceiling fixtures***
- ***Performing preventive maintenance on overhead heaters***

LADDER TASK TIME

Ladder Time (Position & Climb)	To Reach object **(per move)**	Up to 8'	PWP-009A	0.03926
		From 9'-11'	PWP-009B	0.04156
		From 12'-15'	PWP-009C	0.07265
		From 16'-23'	PWP-009D	0.15912
		Over 23'	PWP-009E	0.18212
	Continuous Lateral Movement **(per lin ft)**	Up to 8'	PWP-009F	0.00372
		From 9'-11'	PWP-009G	0.00436
		From 12'-15'	PWP-009H	0.00622
		From 16'-23'	PWP-009I	0.01638
		Over 23'	PWP-009J	0.02295
	Wall Painting/ covering **(per sq ft)**	Walls up to 15'	PWP-009K	0.00043
		Walls over 15'	PWP-009L	0.00205
	Ceiling Painting/ covering **(per sq ft)**	Ceilings up to 15'	PWP-009M	0.00274
		Ceilings over 15'	PWP-009N	0.00382

Figure 7-7. Ladder Task Time Chart

EXAMPLES

- ***Installing electrical cable in overhead raceways***
- ***Spreading mud over drywall tape***

b. Continuous Lateral Movement (PWP-009F thru J). Use when the ladder must be continuously moved laterally as the craftsperson works. Task time is based on the number of linear feet in the job and the height of the work from the ground and includes time to position the ladder, climb up and down and move the ladder aside. Helper time to hold the ladder steady while the craftsperson climbs is included in the task time standard for over 15 feet. Occurrences are based on the number of linear feet in the job.

c. Wall Painting/Covering (PWP-009K-L). Use when a ladder is needed to paint walls or hang wall covering. Time is based on square footage of wall to be painted or covered and includes time to position the ladder, climb up and down, and move the ladder aside. Helper time to hold the ladder steady while the craftperson climbs is included for jobs over 15 feet. Occurrences are based on the number of square feet of wall to be covered.

d. Ceiling Painting/Covering (PWP-009M-N). Use when a ladder is required to paint or cover ceilings. Time is based on the square footage of ceiling to be painted or covered and includes time to position the ladder, climb up and down, and move the ladder aside. Helper time to hold the ladder steady is included for jobs over 15 feet. Occurrences are based on the number of square feet of ceiling to be covered.

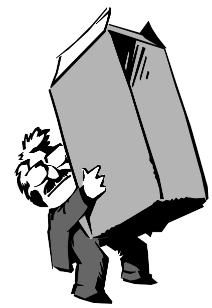
2. <u>Scaffolding Time</u>.

When scaffolding is required, this task provides time to either assemble *<u>or</u>* disassemble, move, raise and lower scaffolding. Time is provided as a time per scaffold section up to and including five sections high. Figure 7-8 provides a chart of the scaffolding task times.

SCAFFOLDING TASK TIME

Pipe Type, Pre Fab	Assemble OR Disassemble per ground level section used	PWP-701A	0.33365
Pipe Type, Pre Fab	Assemble OR Disassemble per above ground section used up to 4 sections	PWP-701A	0.32068
Portable Type, clamp & bracket	Assemble OR Disassemble per ground level section used	PWP-701B	0.19495
Portable Type, clamp & bracket	Assemble OR Disassemble per above ground section used up to 4 sections	PWP-701B	0.31600
Power Type	Raise AND lower (per use)	BT-175	0.65966

Figure 7-8. Scaffolding Task Time Chart



3. Additional Material Handling (AMH).

Standards have been developed in EPS for moving materials, equipment, or debris between storage areas and work sites, moving loaded in one direction and unloaded in the other. Additional material handling standards should not be confused with material handling operations that are part of the task time standard. Material handling within a task time standard is time provided for moving materials in conjunction with the craft work being performed.

PROPER USE OF AMH

- Material from storage to job location
- Material from job location to storage, shop, dumpster, or dump site
- Material from staged location to work location
- Clean up trash at work site to outside refuse container
- Carry job required equipment to/from work site

IMPROPER USE OF AMH

- Handling material at work location while completing work
- Carrying tools of the trade to/from job site

EXAMPLE

REQUIRED WORK (AMH)

Move a carton of ceiling tiles from the shop storeroom into the building to the specific work area to the work site location (point of actual use).

REQUIRED WORK (not AMH):

Move a carton of ceiling tiles from where they were placed at the specific work site to a location across the room, and handle the tiles during the installation process.

Figure 7-9 provides a chart of the Additional Material Handling standards.

Additional Material Handling,(AMH) - **1 Person**	One person per Armload (up to 33 1/3 lbs) per 200' R/T; **Normal Conditions**	PWA-005A	0.04000
Additional Material Handling,(AMH) - **1 Person**	One person per Armload (up to 33 1/3 lbs) per 200' R/T; **Abnormal Conditions**	PWA-005A	0.08000
Additional Material Handling,(AMH) - **1 Person**	One person per Armload (up to 33 1/3 lbs) per 200' R/T; **Extreme Conditions**	PWA-005A	0.12000
Additional Material Handling,(AMH) - **2 Person**	For up to 100lbs.of material handled by two men, 200' R/T; **Normal Conditions**	PWA-005B	0.11000
Additional Material Handling,(AMH) - **2 Person**	For up to 100lbs.of material handled by two men, 200' R/T; **Abnormal Conditions**	PWA-005B	0.22000
Additional Material Handling,(AMH) - **2 Person**	For up to 100lbs.of material handled by two men, 200' R/T; **Extreme Conditions**	PWA-005B	0.33000
AMH using forklift	Load Or unload Pallet & move 100', loaded	PWA-005C	0.03500

Figure 7-9. Additional Material Handling Task Time

a. AMH One Person Standard (PWA-005A). One occurrence of moving an armload of material or equipment consists of one person moving up to 33 1/3 pounds a total round trip distance of up to 200 feet, moving loaded in one direction and unloaded in the other direction. Each single armload includes lifting and setting down the material up to 3 times. The one person standard is used most frequently, and may be used for a craftsperson:

- moving an armload of material or equipment from the shop to the job site
- moving scrap material from the work area to a dumpster or to a trash dump

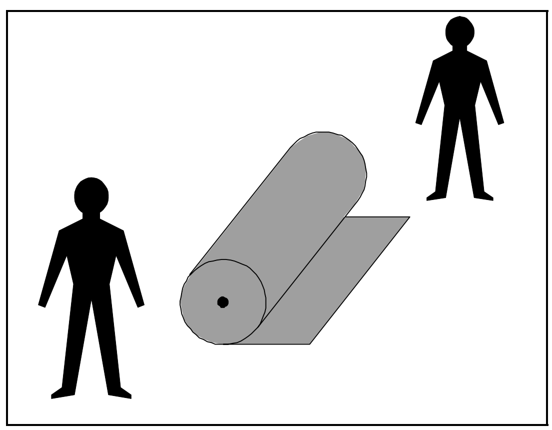
The one person standard should always be used instead of the two person standard, *regardless of crew size*, unless the armload or object is too heavy, bulky, or unwieldy for one person to reasonably handle.

AMHAMA

Determining the weight of the object to be carried and the 200 foot distance that makes up the round trip of travel are both judgement calls on the part of the Planner/Estimator. Excessive time should not be spent determining weight and distance. Most situations should be considered "normal".

b. AMH Two Person Standard (PWA-005B). Moving an object is defined as two people moving a load of material or equipment of any reasonable weight a total round trip distance of up to 200 feet, moving loaded in one direction and unloaded in the other direction. The two person standard is used far less frequently than the one person standard. It may be used for two craftspersons:

- moving a load of material or piece of equipment from the shop to the job site
- moving scrap material from the work area to a dumpster or to a trash dump



The two person standard should be used instead of the one person standard *only* when the armload or object is too heavy, bulky, or unwieldy for one person to reasonably handle. As with the one person standard, crew size is *not* a factor in determining whether the one person or two person standard is required.

c. AMH Using Forklift (PWA-005C, 0.035 hours). When equipment such as a fork lift is used to move materials within a storage area to the truck and off the truck to the work site, the AMH forklift standard is applicable. The AMH forklift standard includes time to load or unload a pallet and move the load approximately 100 feet.

AMH IS NOT A FACTOR OF CREW SIZE.

EXAMPLES

One Person Armload:
- Craftsperson carrying two five gallon buckets of paint from the shop to the work site
- Craftsperson wheeling out a wheelbarrow of debris from a facility to a dumpster

Two Person Armload:
- Two craftspersons carrying 4' x 8' sheets of plywood from a stack in the storage area and loading them into the back of a pickup truck, offloading and carrying to the work site
- Two craftspersons carrying 20' bundles of copper tubing from the warehouse into the work site

Forklift:
- A craftsperson uses a forklift to get a pallet of 2"x4"x8' studs from a storage area in the warehouse and places the pallet load on the truck at the loading dock

d. Travel Conditions. AMH one and two person standards are developed to accommodate the various paths of travel a craftsperson or craftspersons might encounter upon reaching the job site. AMH standard times include an average of both easy (straight, smooth, firm, and unobstructed paths) and difficult travel paths which include:

- Soft Areas — sand, grass, gravel, etc.
- Uneven Pavement — irregular tread, brick, bumpy paths, etc.
- Short Flight of Steps — entrance to building, change in sidewalk level
- Inclines — ramps, small hills, etc.
- Irregular Aisles — cluttered, angled, narrow, etc.
- Tight Working Areas — closets, narrow rooms, etc.
- Office Areas — people, furniture, papers, equipment, etc.

(1) Normal Conditions: The travel conditions described above are considered normal AMH standards travel conditions. They allow for moving material from storage and to the job site under ordinary situations, including moving materials up or down a short flight of stairs or incline, such as the entrance to a building. *The normal condition does not allow time for moving materials from floor to floor via stairs or elevator.*

(2) Abnormal Conditions: The AMH standards for abnormal conditions may be used if the task involves moving materials:

- to floors other than the entry floor, either by elevator or stairs
- up or down scaffolding or ladders
- under other conditions which the Planner/Estimator believes will require additional time beyond normal

(3) Extreme Conditions: The AMH standards for extreme conditions may be used in those *rare* situations where the Planner/Estimator foresees an extraordinary amount of time is required per AMH occurrence due to the nature of the materials or the site conditions. The Planner/Estimator should have sound justification for using the AMH standards for extreme conditions.

EXAMPLES

Normal Conditions:
- Craftsperson removes debris with a wheelbarrow from a first floor work site

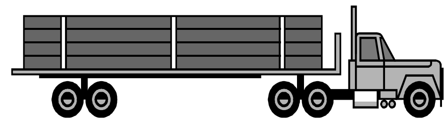
Abnormal Conditions:
- Craftsperson removes debris with a wheelbarrow from a third floor work site and uses the service elevator to get the debris from the third floor to the ground floor

Extreme Conditions:
- Craftspersons move a heavy, bulky piece of equipment required for a job up a narrow stairwell to a fourth floor work site

e. Documenting AMH. AMH calculations should only be based on realistic material handling requirements.. The estimate must document how AMH occurrences are determined for future reference.

4. <u>Heavy Equipment Travel (HET) (PWA-2)</u>.

Heavy and large track equipment normally travels at speeds slower than normal. HET allows workers riding in or waiting for the vehicle sufficient time for the vehicle to get to the job site. HET application is closely tied to Travel Zones and is discussed in detail in conjunction with Travel Time. (See E.3.d. later in this chapter.)



5. <u>Additional Work Location (AWL) (PWA-1, 0.07 hours)</u>.

Maintenance and repair work may require craftspersons to work at different locations while on a job.The additional work location standard provides additional time to travel from the first work site to other locations. Figure 7-10 provides guidance on how to use the AWL standard.

a. Documenting AWL. AWL calculations should be based on realistic travel requirements. By documenting in the estimate how the AWL occurrences are determined someone unfamiliar with the work requirement can quickly understand the number of AWL occurrences.

ADDITIONAL WORK LOCATIONS			
TRAVEL METHOD	**LOCATION**	**CONDITION**	**ADDITIONAL TRAVEL TIME (hrs.)**
Walking	Within Building (room to room)	Carry minimum tools	None
Walking	Within Building (floor to floor)	Carry minimum tools	.07 hrs. per person per move
Walking	Within Building (room to room or floor to floor)	Carry tools and/or equipment and/or material	.07 hrs. per person per move
Walking	Adjacent Buildings	With tools and/or equipment and/or material	.07 hrs. per person per move
Vehicle	Worksite to Worksite (within sector)		.07 hrs. per person per move
Vehicle	Worksite to Worksite (outside sector)		Zone time per person

Figure 7-10. Additional Work Locations Chart

EXAMPLES

REQUIRED WORK:

Two craftsperson must service 4 fire hydrants. They drive to the farthest hydrant first and perform the required work. They need AWL time for the remaining three hydrants.

OCCURRENCES:

2 craftspersons x 3 hydrants = 6 AWLs

CRAFT TIME:

0.07 hours x 6 AWLs = 0.42 hours

* * *

REQUIRED WORK:

A fire alarm mechanic is required to perform preventive maintenance on 5 alarms. One alarm is located on each floor of a five story building. He carries only his tool box. When he arrives he services the alarm on the first floor. AWL time is required for the four remaining alarms.

OCCURRENCES:

1 mechanic x 4 alarms = 4 AWLS

CRAFT TIME:

0.07 x 4 AWLs = 0.28 hours

* * *

REQUIRED WORK:

Janitorial crew of 2 must wash both sides of windows in a single story building. A ladder is required. They wash the exterior windows when they arrive, and now must wash the interior windows in seven rooms.

OCCURRENCES:

2 washers x 7 rooms = 14 AWLs

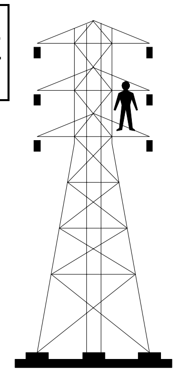
CRAFT TIME:

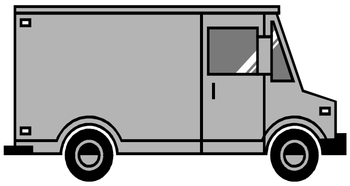
0.07 hours x 14 AWLs = 0.98 hours

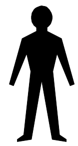
6. <u>Standby/Safety Time</u>.

Standby or safety time is provided for jobs requiring a safety person or standby person in support of the craftsperson(s) performing the task. Standby or safety time is calculated as follows:

$$\boxed{\frac{\text{CRAFT TIME}}{\text{N0. MEN DOING WORK}} = \text{STANDBY / SAFETY TIME}}$$







EXAMPLES

REQUIRED WORK:

An electrician working in a bucket truck on high voltage lines requires a safety person on the ground while the craftsperson is in the bucket.

STANDBY/SAFETY CRAFT TIME:

$$\frac{\text{25 hours electrical craft time}}{\text{1 person electrical crew}} = \text{25 hours standby time}$$

* * *

REQUIRED WORK:

Two electricians working in a bucket truck on high voltage line require a safety person on the ground while they work in the bucket.

STANDBY/SAFETY CRAFT TIME:

$$\frac{\text{25 hours electrical craft time}}{\text{2 person electrical crew}} = \text{12.5 hours standby time}$$

7. <u>Traffic Striping Machine Cleaning Time (PWP-27, 1.1 hours)</u>.

Traffic striping jobs are generally performed using a paint striping machine. This machine requires daily cleaning at the end of each workday. Task time standard PWP-27 provides 1.1 hours of cleaning time that must be calculated into craft time for every job day.

DETERMINING JOB DAYS

STEP #1:

Multiply the number of craftspersons in the crew by the hours in the workday:

3 crew members x 8 hours/day = 24 hours/crewday

STEP #2:

Divide total estimated job hours by crew days:

$$\frac{\text{160 estimated job hours}}{\text{24 hours per crew day}} = \text{6.67 job days}$$

=7 job days (If a job carries over into another day, the machine will have to be cleaned on that day too.)

STEP #3:

Determine craft time for paint striping machine cleaning by multiplying the number of job days by the task time standard.

1.1 hours x 7 days = 7.7 hours craft time

STEP #4:

This additional craft time must be added to the original estimated craft time and the job hours recalculated.

E. GENERAL DATA

When task time standards and Universal Data have been identified, General Data allowances are factored into the estimate to allow the craftspersons sufficient time for job preparation, travel, and craft allowances associated with the particular type of work being performed. General Data is applied by multiplying the total craft time for a job by an EPS General Data Factor (GDF). Figure 7-11 contains the General Data Factors for each craft.

Each element of the General Data Factor is discussed below.

1. Job Preparation.

Associated with every job is time to get ready for the job and time to "finish up" after the craft work has been completed. This time includes:

- receiving the initial job assignment, daily job assignments and associated instructions
- planning the equipment, tool, and material require-ments associated with the work each day
- laying out tools, materials, and equipment at the job site

GENERAL DATA FACTOR TABLE (NEW ALLOWANCES)

CRAFT AREAS	CS	Shop	TRAVEL ZONES 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Boiler	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	M	1.45	1.50	1.52	1.54	1.56	1.59	1.61	1.63	1.69	1.73	1.79	1.84	1.90	1.95	2.08	2.16	2.24
Carpentry (Gen)	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Carpentry (Roofing)	S	1.33	1.36	1.38	1.40	1.42	1.44	1.46	1.48	1.51	1.54	1.59	1.65	1.71	1.77	1.84	1.91	1.99
	M	1.39	1.42	1.44	1.47	1.49	1.51	1.53	1.56	1.58	1.62	1.68	1.74	1.80	1.87	1.94	2.01	2.10
Cooling/Vent/Refr.	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.24	1.27	1.29	1.31	1.32	1.34	1.36	1.38	1.41	1.44	1.49	1.53	1.59	1.64	1.70	1.76	1.83
Electric/Electronic	S	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.38	1.41	1.45	1.50	1.55	1.60	1.66	1.72	1.79
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Heating	S	1.23	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.42	1.46	1.51	1.56	1.62	1.67	1.74	1.80
	M	1.28	1.30	1.32	1.34	1.36	1.38	1.40	1.42	1.44	1.48	1.52	1.57	1.63	1.69	1.75	1.81	1.88
Janitorial	S	1.15	1.17	1.19	1.20	1.22	1.24	1.26	1.27	1.29	1.32	1.36	1.41	1.45	1.50	1.55	1.61	1.67
	M	1.17	1.19	1.21	1.23	1.25	1.26	1.28	1.30	1.32	1.35	1.39	1.44	1.49	1.54	1.59	1.65	1.71
Machine Shop	S	1.30	1.33	1.35	1.37	1.39	1.41	1.43	1.45	1.47	1.51	1.55	1.61	1.66	1.72	1.78	1.85	1.92
	M	1.31	1.34	1.37	1.39	1.41	1.43	1.45	1.48	1.50	1.54	1.59	1.64	1.70	1.76	1.83	1.90	1.97
Machine Repairs	S	1.39	1.42	1.43	1.45	1.48	1.50	1.52	1.53	1.57	1.60	1.65	1.72	1.77	1.84	1.91	1.98	2.06
	M	1.49	1.53	1.55	1.57	1.59	1.62	1.64	1.70	1.72	1.77	1.82	1.87	1.93	2.05	2.11	2.20	2.27
Masonry (Gen)	S	1.23	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.42	1.46	1.51	1.56	1.62	1.68	1.74	1.81
	M	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.44	1.46	1.49	1.54	1.59	1.65	1.71	1.77	1.84	1.91
Masonry (Purchased)	S	1.27	1.30	1.32	1.34	1.36	1.38	1.40	1.42	1.44	1.47	1.52	1.57	1.62	1.68	1.74	1.81	1.88
	M	1.31	1.34	1.36	1.38	1.40	1.42	1.44	1.46	1.48	1.52	1.57	1.62	1.68	1.74	1.80	1.87	1.94
Moving/Rigging	S	1.35	1.38	1.40	1.42	1.44	1.47	1.49	1.51	1.53	1.57	1.62	1.67	1.73	1.79	1.86	1.93	2.00
	M	1.49	1.53	1.55	1.57	1.60	1.62	1.65	1.67	1.70	1.74	1.80	1.86	1.93	2.00	2.07	2.15	2.24
Multi-Trade	S	1.23	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.42	1.46	1.51	1.56	1.62	1.67	1.74	1.80
	M	1.28	1.30	1.32	1.34	1.36	1.38	1.40	1.42	1.44	1.48	1.52	1.57	1.63	1.69	1.75	1.81	1.88
Paint (Gen)	S	1.20	1.23	1.24	1.26	1.28	1.29	1.31	1.33	1.35	1.38	1.43	1.47	1.52	1.57	1.63	1.68	1.75
	M	1.21	1.24	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.40	1.44	1.49	1.54	1.59	1.65	1.71	1.78
Paint (Spray)	S	1.21	1.24	1.25	1.27	1.29	1.31	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.58	1.64	1.70	1.76
	M	1.23	1.26	1.28	1.30	1.31	1.33	1.35	1.37	1.39	1.43	1.47	1.52	1.57	1.62	1.68	1.74	1.81
Pest Control	S	1.18	1.21	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.37	1.41	1.46	1.51	1.56	1.61	1.67	1.74
	M	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.39	1.42	1.47	1.52	1.57	1.62	1.68	1.75	1.82
Pipefitting (Int)	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Pipefitting (Ext)	S	1.24	1.27	1.28	1.30	1.32	1.34	1.36	1.38	1.40	1.43	1.48	1.53	1.58	1.63	1.69	1.75	1.82
	M	1.32	1.35	1.37	1.39	1.41	1.43	1.45	1.47	1.49	1.53	1.58	1.63	1.68	1.74	1.81	1.87	1.95
Plumbing (Int)	S	1.23	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.42	1.46	1.51	1.56	1.62	1.67	1.74	1.80
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Plumbing (Ext)	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Roads & Grounds (Gen)	S	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.38	1.41	1.45	1.50	1.55	1.60	1.66	1.72	1.79
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Roads & Grounds (Labor)	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Sheetmetal	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Stru Iron/Weld (Shop)	S	1.23	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.42	1.46	1.51	1.56	1.62	1.67	1.74	1.80
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Stru Iron/Weld (Fld)	S	1.29	1.32	1.34	1.36	1.38	1.40	1.42	1.44	1.46	1.50	1.55	1.60	1.66	1.72	1.79	1.86	1.93
	M	1.36	1.38	1.41	1.43	1.45	1.47	1.49	1.52	1.54	1.58	1.63	1.69	1.75	1.82	1.89	1.96	2.04
Trackage	S	1.31	1.34	1.36	1.38	1.40	1.42	1.44	1.46	1.49	1.52	1.57	1.63	1.68	1.74	1.81	1.88	1.95
	M	1.32	1.35	1.37	1.39	1.41	1.43	1.46	1.48	1.50	1.54	1.59	1.65	1.71	1.77	1.84	1.91	1.99
Wharfbuilding	S	1.36	1.39	1.41	1.43	1.45	1.47	1.49	1.52	1.54	1.58	1.63	1.69	1.75	1.81	1.88	1.96	2.03
	M	1.46	1.49	1.52	1.54	1.57	1.59	1.62	1.64	1.67	1.71	1.77	1.83	1.90	1.97	2.05	2.13	2.22

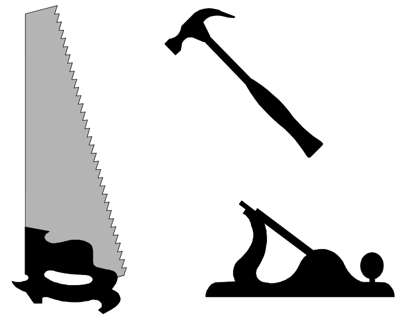
1. Crewsizes over 6, add 0.1 to GDF. 2. Hazardous work add 0.1 to GDF. 3. Return for lunch: TZ's 2-5 add 0.1; 6-9 add 0.2; 10+ add 0.3.

Figure 7-11. General Data Factor Table

- generally getting ready to begin the craft work portion of the job

It also includes time for:

- storage of tools, materials, and equipment
- minor work space cleanup at the end of the day or the job



Job Preparation time is given in labor hours per workday with the times differing by trade. Figure 7-12 provides a summary of the job preparation time for each trade.

a. Hazardous Work Situation. When a normally non hazardous job is found to have some hazardous situation related to it, job preparation time can be increased by adding an adjustment of 0.1 to the GDF for the craft.

EXAMPLES

REQUIRED WORK:

Remove concrete floor in confined space with limited ventilation. Respirator required due to high level of concrete dust.

HAZARDOUS JOB PREPARATION:

Normally concrete removal does not warrant a respirator. A simple mask is sufficient. Use of a respirator requires that the device be checked for a clean filter and cleaned at the the conclusion of the day.

When considering adding hazardous work situation time check the task time standard operations to determine whether additional preparation time is built into the task. Pest control application standards and asbestos insulation standards have additional time built into the tasks for donning protective clothing.

CRAFTS		JOB PREP	%CRAFT ALLOWANCE ONE MAN	MULTI-MAN
BOILER WORK- BY ANY SHOP		.4	23	33
CARPENTRY	GENERAL	.3	15	20
	ROOFING	.6	20	25
COOLING/VENTILATING/REFRIG.		.3	15	18
ELECTRICAL/ELECTRONIC		.3	16	20
HEATING		.3	17	21
JANITORIAL		.3	11	13
MACHINE SHOP		.3	23	24
MACHINE REPAIR		.4	28	36
MASONRY	GENERAL	.4	15	20
	PURCHASED CONCRETE	.4	19	22
MULTI-TRADE SHOPS (ZONE CONCEPT)		.3	17	21
MOVING AND RIGGING		.3	28	40
PAINT	GENERAL	.2	16	17
	SPRAY	.2	17	19
PEST CONTROL		.3	14	17
PIPEFITTING	INTERIOR	.3	15	20
	EXTERIOR	.3	18	25
PLUMBING	INTERIOR	.3	17	20
	EXTERIOR	.3	15	20
ROADS & GROUNDS	GENERAL	.3	16	20
	LABORER	.3	15	20
SHEETMETAL		.3	15	20
STRUCTURAL	SHOP	.3	17	20
IRON & WELDING	FIELD	.6	17	22
TRACKAGE		.4	-	22
WHARFBUILDING		.5	17	21

The above allowances are included in the General Data Factor (GDF) they are provided here in table format for use in entering these allowances in FEJE based automated estimating systems.

Figure 7-12. Summary of General Data Chart

2. <u>Craft Allowance</u>.

Craft allowance is a percentage of craft time that is added for allowable situations that occur during work accomplishment, but are not craft time. Craft allowances (shown in Figure 7-12) are made up of the following:

a. Planning. When craftspersons begin a job and at various times during the accomplishment of the job, on the job planning time is required. This time includes:

- pertinent discussions among the crew about what is to be done
- checking specifications and job plans, reading blueprints, taking measurements, and marking the work site

b. Balancing Delay. When work assignments require two or more workers, balancing delays occur. During a job there are times when one of the workers cannot proceed or continue work until work performed by others is completed. Balancing delay only applies to work being performed by a single craft. Because balancing delays only occur when more than worker is assigned to the job, the chart in Figure 7-12 shows the allowances in two columns, one for single man and one for multi-person crews.

EXAMPLES

- ***One electrician waits while a second electrician runs fish tape through conduit prior to pulling wire.***
- ***One painter finishes before his partner and must wait to move the scaffolding.***

c. Personal. Craftspersons require time during the course of a job to attend to personal needs as well as to rest their bodies when strenuous work is being performed. Included in these personal requirements are the following:

- time for coffee breaks
- smoking breaks
- rest room visits
- rest time associated with letting the body recover after performing a physically demanding task

d. Unavoidable Delay. Some delays associated with performing work result from unforeseen interruptions that are part of performing the work, and are unavoidable. On the other hand, ***avoidable delays*** are delays that are either condoned by management or within management's power to eliminate, and are *not* included in craft delay allowance. Avoidable delays include:

- **Official Time:** Time to attend safety meetings, go to the dispensary, etc.

EXAMPLES

- ***Replacing a broken drill bit***
- ***Filing smooth a piece of material to allow it to assemble correctly***
- ***Changing a saw blade***
- ***Re-tightening a router bit***

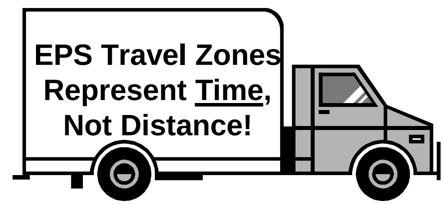
- **Avoidable Work Delays:** Waiting for material that should have been staged at the job site prior to the craftsperson's arrival, returning to the shop to get more tools, untrained labor etc.
- **Other Non-Productive Delays**: Long waits for transportation, waiting in line at the tool crib, inclement weather, waiting in line to gas up the truck, etc.

3. Travel Time.

Travel time includes one round trip of travel, per person, per day between the shop and the job site, and is factored into the General Data Factor based on EPS travel zone times.

a. Travel Zone Maps. EPS travel time is divided into segregated intervals of time called *Travel Zones*. Every EPS Travel Zone Map is unique because each one is developed for the specific installation on which it is to be used. Figure 7-13 is a sample Travel Zone Map. (See Appendix D for details on Travel Zone Map development).

b. Travel Zones.



• **Travel Zone 0 (0.0 hours)** — is the Travel Zone of the shop area. No travel hours are required when the when the work is performed in the shop.

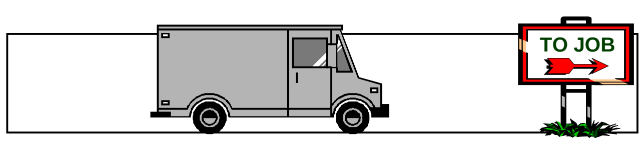
• **Travel Zone 1 (0.16 hours)** — excludes vehicle travel and provides time for each craftsperson to walk with tools to locations less than 2500 feet round trip from the shop.

• **Travel Zones 2 - 16 (0.25 - 2.4 hours)** — provides time for each craftsperson using a vehicle to travel round trip between the shop area and the job site in Travel Zones 2 and above. For work requiring a vehicle in Zone 1, Travel Zone 2 should be used.

Round Trip Travel Time Chart																	
Zone Number	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Allowed Time (Hrs)	.00	.16	.25	.35	.45	.55	.65	.75	.85	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4

In addition to the actual time spent in the vehicle driving from the shop to the site and back, a round trip of travel includes 0.2238 hours or about 13.4 minutes of time for activities associated with traveling to and from the job site. These activities include:

- Waiting a short time (less than 6 min.) for a vehicle
- Loading a hand carried tool box into a vehicle
- Walking from a vehicle to the job site
- Reversing the above activities



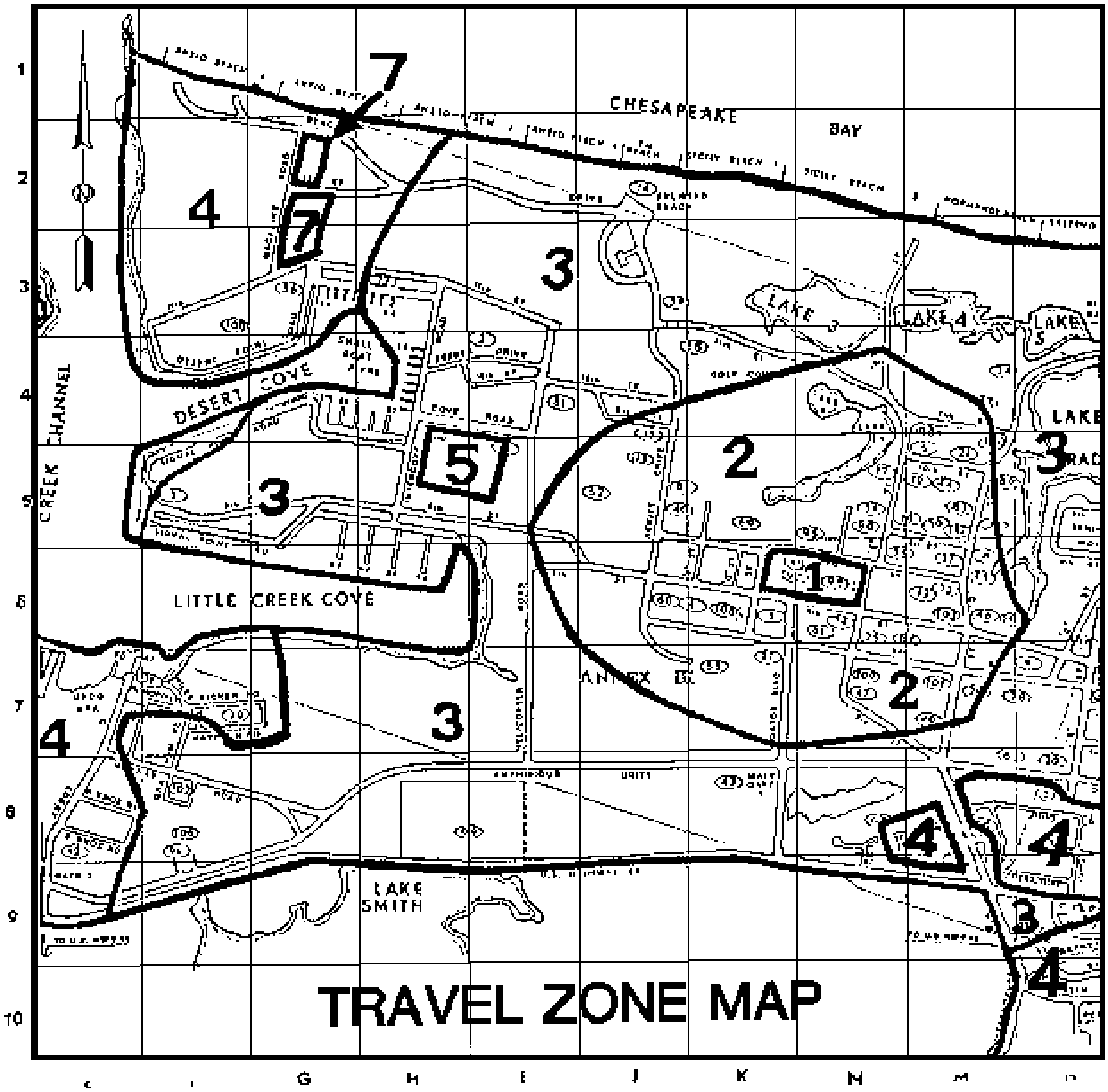
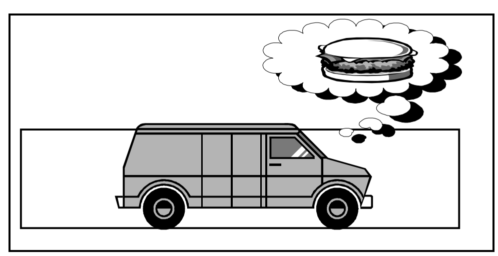


Figure 7-13. Sample Travel Zone Map

c. Travel Situations



- **Returns To the Shop For Lunch.** Craftspersons being permitted to return to their shops for lunch is based on local policy. If it is the established installation policy or part of negotiated labor agreement, the Planner/ Estimator must adjust the GDF to account for this additional round trip of travel each day. The adjustment is made by adding to the GDF:

- 0.1 for travel in Zones 2 through 5
- 0.2 for travel in Zones 6 through 9
- 0.3 for travel in Zones 10 and above

- **Trips in the Opposite Direction.** Some jobs require work in more than one location. When travel is along the same route, additional travel time of 0.07 hours is added per worker per stop. However, when extra work requirements are in the opposite direction from the shop, the Planner/Estimator must add additional Travel Zone time in the estimate. Frequency of the trips in the opposite direction dictates how the Planner/Estimator handles addition of this travel time.

(1) Daily Trips in the Opposite Direction.

When a job requires a daily trip in the opposite direction, travel time is provided by adjusting the GDF in the same manner as returns to the shop for lunch (discussed above). The Planner/Estimator must select the appropriate adjustment factor for the travel zone of the opposite direction destination.

This situation assumes that the daily trips in the opposite direction are made at the end of each workday, with the crew returning to the shop upon completion of the work. The adjusted GDF will provide travel time for each member of the crew involved in travel.

EXAMPLES

- ***A trip to the dump every day to unload debris***
- ***A trip to a laboratory every day to bring samples for testing***

DAILY TRIPSDD

Daily trips in the opposite direction are handled in the same manner as returns to the shop for lunch.

EXAMPLE
Daily Trips in the Opposite Direction

REQUIRED WORK:

During a remodeling job in zone 5, a daily trip to the dump in Zone 6 in the opposite direction is required for a crew of two carpenters.

STEP #1:

Determine the Total Craft Hours for the job. For this example, assume that the job requires 88 EPS Craft Hours.

EXAMPLE (cont)

STEP #2:

The GDF for Carpentry (General), multi-crew, Travel Zone 5 is 1.37. Since the dump is in Zone 6 (opposite direction), the adjustment to the GDF is 0.2 (see the General Data Factor Table, Returns for Lunch, Travel Zones 6-9).

GDF= 1.37+ 0.2= 1.57

STEP #3:

The Total Labor Hour Requirement for the phase:

88 hours x 1.57= 139 hours

(2) Fixed Number of Trips in the Opposite Direction During the Job.

When a job requires a daily trip in the opposite direction at some point during the job, the requirement is treated like a task. Each member of the crew involved in travel is given a round trip of travel based on the number of trips required during the job and whether an immediate return to the job site is required. The round trip time for travel to Zones 1 - 16 is found in the General Data Handbook.

EXAMPLES

- ***A single trip to the dump at the end of a job to unload debris***
- ***Multiple trips during a job to haul 120 cu. yd. of excavated soil to a dump site using two 7 cu. yd. dump trucks***

- Without Immediate Return to the Job Site. This situation assumes that each trip for the fixed number of trips in the opposite direction is made at the end of a workday, with the crew involved in travel returning to the shop upon completion of the work. The travel time is treated as an EPS task, and includes a round trip of travel to the destination Travel Zone for each trip for each member of the crew involved in travel.

EXAMPLE

Fixed Number of Trips in the Opposite Direction

(Without Immediate Return to Job Site)

REQUIRED WORK:

During a five day remodeling job, one trip per day to the dump for the first two days of the job is required for a crew of two. The dump is in Zone 4 in the opposite direction. Since the two trips to the dump would logically occur at the end of the first two workdays, immediate return to the job site would not be required.

STEP #1:

Add an EPS task to provide travel time to Zone 4:

PWA 001D = 0.45000 hours per person per round trip

EXAMPLE (cont.)

STEP #2:

Determine the total number of trips required for the two person crew:

2 trips x 2 craftspersons = 4.0 occurrences

STEP #3:

Determine the travel time for the additional round trips of travel to the dump in the opposite direction. Multiply the Travel Zone time (Unit Hours) by the number of occurrences:

0.45000 hours x 4.0 occurrences = 1.800 hours

STEP #4:

Compute the Total Labor Hour Requirement, including the task time for the fixed number of trips in the opposite direction as part of the requirement.

- With Immediate Return to the Job Site. This situation assumes that each trip for the fixed number of trips in the opposite direction is made during the workday, with the crew involved in travel returning immediately to the job site. The travel time is treated as an EPS task, and includes a round trip of travel to the destination Travel Zone, *plus* a round trip of travel back to the job site for each trip for each member of the crew. This situation is different from the one discussed above in that travel time must be included for returning to the job site instead of returning to the shop.

EXAMPLE
Fixed Number of Trips in the Opposite Direction
(With Immediate Return to Job Site)

REQUIRED WORK:

During a construction job in Zone 4, 95 cubic yards of excavated soil must be transported from the job site to a stock pile in Zone 5 in the opposite direction. The crew has available one 7 cubic yard capacity dump truck, and one craftsperson will be assigned to the truck. Since the trips to the stock pile will be made repeatedly during the work day, immediate returns to the job site are required.

STEP #1:

Add an EPS task to provide travel time for the crew to Travel Zone 4 plus travel time to Travel Zone 5:

PWA 001D = 0.45000 hours per person per round trip
PWA 001E = 0.55000 hours per person per round trip
Total time = 1.00000 hours per person per round trip

EXAMPLE (cont.)

STEP #2:

Determine the total number of trips required to move the soil:

$$\frac{95 \text{ cu. yd. of soil}}{7 \text{ cu. yd. per truckload}} = 13.6 \text{ trips} = 14 \text{ trips}$$

STEP #3:

Determine the total number of occurrences:

14 trips x 1 craftsperson per trip = 14.0 occurrences

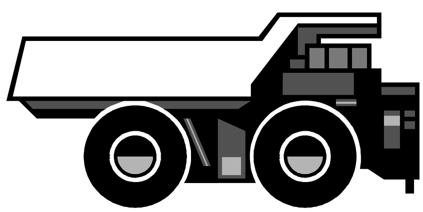
STEP #3:

Determine the travel time for the additional round trips of travel to the dump in the opposite direction:

1.00000 hours x 14 occurrences = 14.000 hours

STEP #4:

Compute the Total Labor Hour Requirement, including the task time for the fixed number of trips in the opposite direction as part of the requirement.



• **Travel Sectors.** Sometimes it is difficult to determine if an additional work location is in the same direction or in the opposite direction from the principal work location. Determining the travel sectors of a job can help in making the determination. Figures 7-14 and 7-15 provide examples of a sectored Travel Zone Map.

EXAMPLE

REQUIRED WORK:

Point "A" - location where the majority of the work will be done

Point "B" - additional work location

Point "C" - location of the dump where craftspersons must dispose of debris at the end of the job

EXAMPLE (cont.)

TRAVEL SECTORS:

STEP #1:
Using a reduced copy of the Travel Zone Map for the installation draw a straight line between the **first** work location ("A") and the Shop Area ("O"). Extend the line to the edges of the Travel Zone Map. *Name the line "ROS" - put the letters "R" and "S" at the points where the line meets the edges of the Travel Zone Map.*

STEP #2:
Draw a line perpendicular (at a 90 degree angle) to line "ROS" using the Shop Area ("O") as the starting point. Extend the line to the perimeter of the Travel Zone Map. *Name the line "POQ" - put the letters "P" and "Q" at the points where the line meets the edges of the Travel Zone Map.* See Figure 7-14.

STEP #3:
Determine the sectors with respect to work location “A”.

- Work occurring within the lines "OP", "OS", and "OQ" is considered to be within the travel sector of work location “A".
- Work to be done at work location "B" is within the travel sector of work location “A”, and requires AWL travel time of 0.07 hours per person added as task time.

STEP #4:
Redraw line “ROS” as described in STEP #1. Using the **second** work location (“B”) as the current work location, and redraw line “ROS” between “B” and the Shop Area (“O”). Extend the new line to the edges of the Travel Zone Map.

STEP #5:
Redraw line “POQ” as described in STEP #2. See Figure 7-15

STEP #6:
Determine the sectors with respect to work location “B”.

- Work occurring within the **redefined** lines "OP", "OS", and "OQ" is considered to be within the travel sector of work location “B".- The trip to "C" to dump debris is outside the travel sector of "B, and requires an additional round trip of travel to Zone 3 be added per craftsperson as a task time.

STEP #7:
Repeat STEP #4 through STEP #6 for all remaining work locations, redrawing the lines and redefining the sectors with respect to each successive work location.

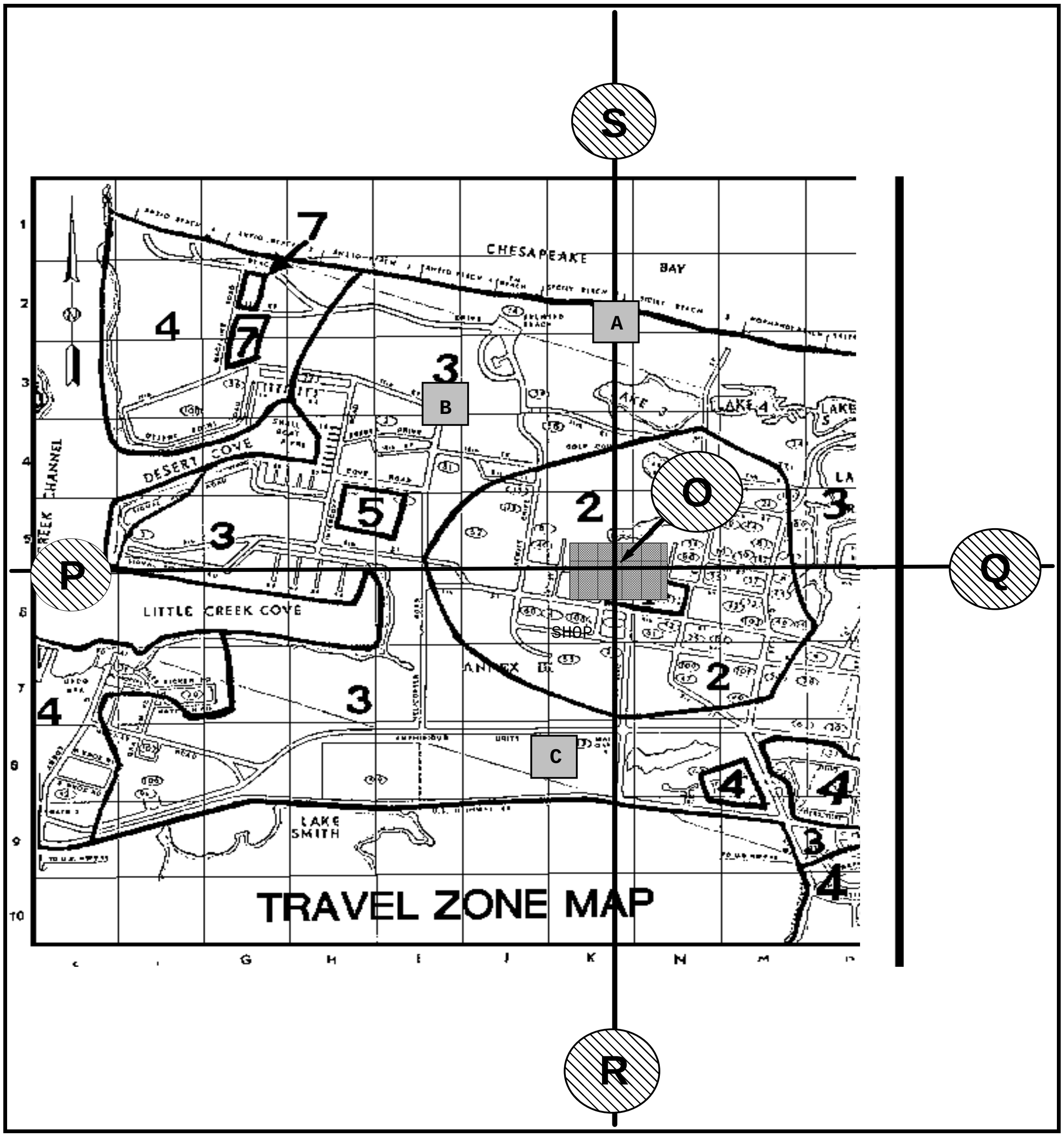


Figure 7-14. Sample Travel Zone Map (Location “A” Sector Definition)

In order to determine travel sectors with respect to each successive work location, the Planner/Estimator must plan the travel route based on how he believes the craftspersons will logically travel from location to location in completing the work requirement. An important point to keep in mind when defining travel sectors is that sectors are **only** relative to the current work location, and totally independent of previous work locations.

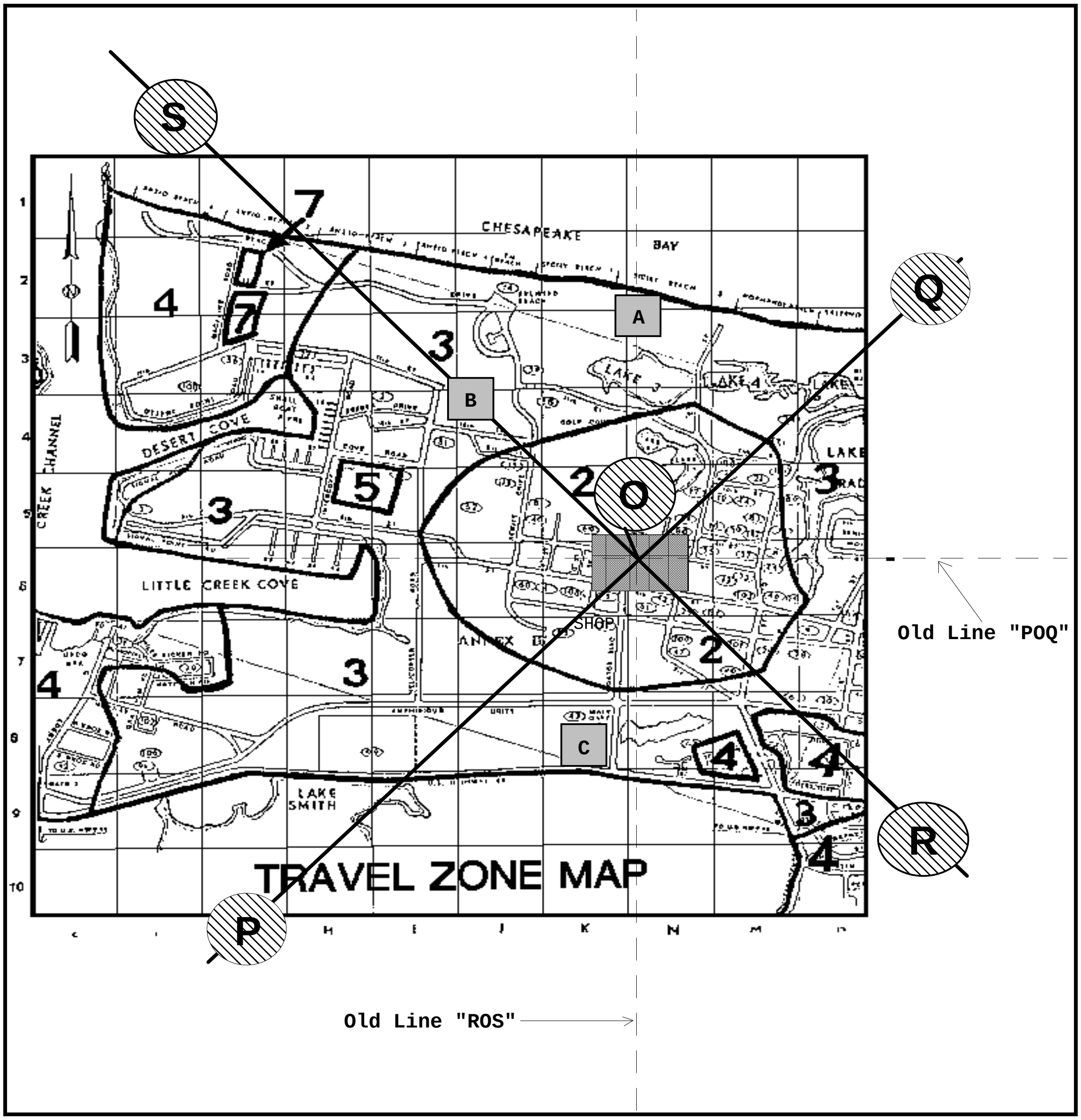


Figure 7-15. Sample Travel Zone Map (Location "B" Sector Definition)

• **Travel Zones Beyond Travel Zone 16 (+ 2.4 hours).** Some large installations have remote sites that are beyond the 2.4 hours of travel in Zone 16. When the travel time exceeds 2.4 hours per round trip, very little time remains during a work day for craftspersons to accomplish work. Additional travel beyond Zone 16 is calculated based on the number of job days. Each day the craftspersons go to the job site, they need additional travel time beyond what is provided through the application of the General Data Factor.

EXAMPLE

REQUIRED WORK:

Crew of 4 must make a 3 hour round trip to the work site. The initial estimate for the job is 125 hours.

STEP #1:

Multiply the number of craftspersons in the crew by the hours in the workday:

4 crew members x 8 hours/day = 32 hours/crew day

STEP #2:

Divide the total estimated job hours by the crew days:

$$\frac{\text{125 estimated job hours}}{\text{32 hours per crew day}} = \text{3.9 job days}$$

=4 job days (if a job carries over into another day, the crew must make a round trip on the partial day to complete the work.

STEP #3:

Determine the amount of travel time beyond Travel Zone 16.

3 hours - Travel Zone 16 (2.4 hours) = 0.6 hours

STEP #4:

Determine the additional round trip travel time for the crew.

4 crew members x 0.6 hours x 4 job days = 9.6 hours

STEP #5:

Add the time computed in STEP #4 as a task.

d. Heavy Equipment Travel. Heavy equipment (bucket trucks, backhoes, lowbeds, cranes, etc.) may be required to assist in accomplishing work. Because of their size or weight, they do not move at the same speed or in some cases take the same route as other vehicles. Since Travel Zone Map development is based on the travel of standard vehicles, additional travel time may be added to the estimate to allow workers riding in or waiting for the vehicle sufficient time to get to the job site. Figure 7-16 provides a chart of the additional time that must be added as task time per crew member when heavy equipment is utilized.

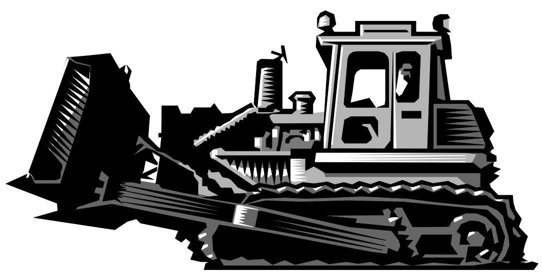
HET

HET is not given each day of the job because heavy equipment normally remains at the job site until the job is complete.

HEAVY EQUIPMENT TRAVEL (HET)

Traveling from: Zone 0 (Shop) to Zone (X) (No HET for Zone 1,2 & 3)	Additional Travel Time for heavy equipment movement per person per round trip.	Reference
Zone 0 - Zone 4 & return	0.11000	PWA 002A
Zone 0 - Zone 5 & return	0.19000	PWA 002B
Zone 0 - Zone 6 & return	0.27000	PWA 002C
Zone 0 - Zone 7 & return	0.35000	PWA 002D
Zone 0 - Zone 8 & return	0.43000	PWA 002E
Zone 0 - Zone 9 & return	0.55000	PWA 002F
Zone 0 - Zone 10 & return	0.71000	PWA 002G
Zone 0 - Zone 11 & return	0.87000	PWA 002H
Zone 0 - Zone 12 & return	1.03000	PWA 002I
Zone 0 - Zone 13 & return	1.19000	PWA 002J
Zone 0 - Zone 14 & return	1.35000	PWA 002K
Zone 0 - Zone 15 & return	1.51000	PWA 002L

Figure 7-16. Heavy Equipment Travel Time



EXAMPLE

REQUIRED WORK:

A crew of 2 is required to relamp stadium lights at the Stadium in Zone 6.

EPS TASK:

PWA 002C HET to Zone 6
0.27000 hours

CRAFT TIME:

0.27000 x 2 crew members = .54 hours

e. Partial Day Influence. Partial day influence is time added for additional travel and job preparation time required by the majority of jobs performed. Because there is no way for a planner to know when a job will start and because jobs do not necessarily start and end with the workday, the GDF provides an allowance. It provides sufficient time for an additional round trip of travel and job preparation per crew member in case the job starts in the middle of a day and ends in the middle of another day.

EXAMPLE

REQUIRED WORK:

A crafts person is assigned to perform a 20 hour job.

Day #1: Job Start Time:	2:00 p.m.
Day #1: End Time	4:00 p.m.
(Hours worked = 2)	
Day #2: Job Start Time:	8:00 a.m.
Day #2: End Time	4:00 p.m.
(Hours worked = 8)	
Day #3: Job Start Time:	8:00 a.m.
Day #3: End Time	12:00 p.m
(Hours worked = 4)	
(Total hours worked = 14)	

PARTIAL DAY INFLUENCE:

The GDF provides for an additional round trip of travel and job preparation for this job.

5. <u>The General Data Factor</u>.

a. Selecting the General Data Factor.

The General Data Factor chart is located on the reverse side of the Job Planning & Estimating (JP&E) Worksheets (presented in Chapter VIII). To select the correct GDF, take the following steps:

STEP #1:

Select the appropriate Craft Area.

STEP #2:

Based on the crew size select the multi-crew (M) or single-man (S) row in the appropriate craft area.

STEP #3:

Based on the Travel Zone in which the majority of the work will occur, select the appropriate Travel Zone column.

STEP #4:

Read the General Data Factor where the Craft Area based on crew size line meets the Travel Zone column.

EXAMPLE

REQUIRED WORK:

A crew of 4 painters are given a job to paint the walls of Building P01 in Travel Zone 6.

DETERMINE THE GDF (refer to Figure 7-17):

STEP #1:
Read down the Craft Area column to Paint (Gen).

STEP #2:
Select the "M" line of the Paint (Gen) craft area since the crew size is 4.

STEP #3:
Under Travel Zones locate Travel Zone 6.

STEP#4:
Draw a line from the Paint (Gen) "M" line across to where it meets the Travel Zone 6 column and read the GDF for the estimate.

GDF = 1.33

b. Adjusting the General Data Factor.

In some specific situations the General Data Factor must be adjusted. These situations include:

- **Hazardous Work Situations.** As discussed under General Data, when a normally non hazardous work situation is found to have hazardous situation, the General Data factor may be adjusted by adding 0.1.

- **Crew Size Over 6.** When the crew size is over 6 members, the GDF should by adjusted by adding 0.1 to provide sufficient partial day influence.

- **Returns to the Shop for Lunch.** When a crew is permitted to return to the shop for lunch each day of the job, the GDF is adjusted to allow for the additional round trip of travel and job preparation associated with the return for lunch. This adjustment is dependent upon the Travel Zone in which the work is being performed.

  Travel Zones 2-5 add 0.1
  Travel Zones 6-9 add 0.2
  Travel Zones 10+ add 0.3

GENERAL DATA FACTOR TABLE (NEW ALLOWANCES)

CRAFT AREAS	CS	Shop	TRAVEL ZONES 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Boiler	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	M	1.45	1.50	1.52	1.54	1.56	1.59	1.61	1.63	1.69	1.73	1.79	1.84	1.90	1.95	2.08	2.16	2.24
Carpentry (Gen)	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Carpentry (Roofing)	S	1.33	1.36	1.38	1.40	1.42	1.44	1.46	1.48	1.51	1.54	1.59	1.65	1.71	1.77	1.84	1.91	1.99
	M	1.39	1.42	1.44	1.47	1.49	1.51	1.53	1.56	1.58	1.62	1.68	1.74	1.80	1.87	1.94	2.01	2.10
Cooling/Vent/Refr.	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.24	1.27	1.29	1.31	1.32	1.34	1.36	1.38	1.41	1.44	1.49	1.53	1.59	1.64	1.70	1.76	1.83
Electric/Electronic	S	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.38	1.41	1.45	1.50	1.55	1.60	1.66	1.72	1.79
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Heating	S	1.23	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.42	1.46	1.51	1.56	1.62	1.67	1.74	1.80
	M	1.28	1.30	1.32	1.34	1.36	1.38	1.40	1.42	1.44	1.48	1.52	1.57	1.63	1.69	1.75	1.81	1.88
Janitorial	S	1.15	1.17	1.19	1.20	1.22	1.24	1.26	1.27	1.29	1.32	1.36	1.41	1.45	1.50	1.55	1.61	1.67
	M	1.17	1.19	1.21	1.23	1.25	1.26	1.28	1.30	1.32	1.35	1.39	1.44	1.49	1.54	1.59	1.65	1.71
Machine Shop	S	1.30	1.33	1.35	1.37	1.39	1.41	1.43	1.45	1.47	1.51	1.55	1.61	1.66	1.72	1.78	1.85	1.92
	M	1.31	1.34	1.37	1.39	1.41	1.43	1.45	1.48	1.50	1.54	1.59	1.64	1.70	1.76	1.83	1.90	1.97
Machine Repairs	S	1.39	1.42	1.43	1.45	1.48	1.50	1.52	1.53	1.57	1.60	1.65	1.72	1.77	1.84	1.91	1.98	2.06
	M	1.49	1.53	1.55	1.57	1.59	1.62	1.64	1.70	1.72	1.77	1.82	1.87	1.93	2.05	2.11	2.20	2.27
Masonry (Gen)	S	1.23	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.42	1.46	1.51	1.56	1.62	1.68	1.74	1.81
	M	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.44	1.46	1.49	1.54	1.59	1.65	1.71	1.77	1.84	1.91
Masonry (Purchased)	S	1.27	1.30	1.32	1.34	1.36	1.38	1.40	1.42	1.44	1.47	1.52	1.57	1.62	1.68	1.74	1.81	1.88
	M	1.31	1.34	1.36	1.38	1.40	1.42	1.44	1.46	1.48	1.52	1.57	1.62	1.68	1.74	1.80	1.87	1.94
Moving/Rigging	S	1.35	1.38	1.40	1.42	1.44	1.47	1.49	1.51	1.53	1.57	1.62	1.67	1.73	1.79	1.86	1.93	2.00
	M	1.49	1.53	1.55	1.57	1.60	1.62	1.65	1.67	1.70	1.74	1.80	1.86	1.93	2.00	2.07	2.15	2.24
Multi-Trade	S	1.23	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.42	1.46	1.51	1.56	1.62	1.67	1.74	1.80
	M	1.28	1.30	1.32	1.34	1.36	1.38	1.40	1.42	1.44	1.48	1.52	1.57	1.63	1.69	1.75	1.81	1.88
Paint (Gen)	S	1.20	1.23	1.24	1.26	1.28	1.29	1.31	[illegible]	1.35	1.38	1.43	1.47	1.52	1.57	1.63	1.68	1.75
	M	1.21	1.24	1.26	1.27	1.29	1.31	1.33	[illegible]	1.37	1.40	1.44	1.49	1.54	1.59	1.65	1.71	1.78
Paint (Spray)	S	1.21	1.24	1.25	1.27	1.29	1.31	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.58	1.64	1.70	1.76
	M	1.23	1.26	1.28	1.30	1.31	1.33	1.35	1.37	1.39	1.43	1.47	1.52	1.57	1.62	1.68	1.74	1.81
Pest Control	S	1.18	1.21	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.37	1.41	1.46	1.51	1.56	1.61	1.67	1.74
	M	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.39	1.42	1.47	1.52	1.57	1.62	1.68	1.75	1.82
Pipefitting (Int)	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Pipefitting (Ext)	S	1.24	1.27	1.28	1.30	1.32	1.34	1.36	1.38	1.40	1.43	1.48	1.53	1.58	1.63	1.69	1.75	1.82
	M	1.32	1.35	1.37	1.39	1.41	1.43	1.45	1.47	1.49	1.53	1.58	1.63	1.68	1.74	1.81	1.87	1.95
Plumbing (Int)	S	1.23	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.42	1.46	1.51	1.56	1.62	1.67	1.74	1.80
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Plumbing (Ext)	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Roads & Grounds (Gen)	S	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.38	1.41	1.45	1.50	1.55	1.60	1.66	1.72	1.79
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Roads & Grounds (Labor)	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Sheetmetal	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Stru Iron/Weld (Shop)	S	1.23	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.42	1.46	1.51	1.56	1.62	1.67	1.74	1.80
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Stru Iron/Weld (Fld)	S	1.29	1.32	1.34	1.36	1.38	1.40	1.42	1.44	1.46	1.50	1.55	1.60	1.66	1.72	1.79	1.86	1.93
	M	1.36	1.38	1.41	1.43	1.45	1.47	1.49	1.52	1.54	1.58	1.63	1.69	1.75	1.82	1.89	1.96	2.04
Trackage	S	1.31	1.34	1.36	1.38	1.40	1.42	1.44	1.46	1.49	1.52	1.57	1.63	1.68	1.74	1.81	1.88	1.95
	M	1.32	1.35	1.37	1.39	1.41	1.43	1.46	1.48	1.50	1.54	1.59	1.65	1.71	1.77	1.84	1.91	1.99
Wharfbuilding	S	1.36	1.39	1.41	1.43	1.45	1.47	1.49	1.52	1.54	1.58	1.63	1.69	1.75	1.81	1.88	1.96	2.03
	M	1.46	1.49	1.52	1.54	1.57	1.59	1.62	1.64	1.67	1.71	1.77	1.83	1.90	1.97	2.05	2.13	2.22

1. Crewsizes over 6, add 0.1 to GDF. 2. Hazardous work add 0.1 to GDF. 3. Return for lunch: TZ's 2-5 add 0.1; 6-9 add 0.2; 10+ add 0.3.

Figure 7-17. General Data Factor Example

EXAMPLES

REQUIRED WORK:

A one man crew is to remove concrete in a confined area of Building N297 in Travel Zone 5. The work requires the use of a respirator. Additional hazardous situation job preparation time is required.

GDF ADJUSTMENT:

Craft Area:	Masonry (Gen)
Crew Size:	S = single
Travel Zone:	Zone 5
GDF:	1.33
Hazardous Situation:	0.1

Adjusted GDF = 1.33 + 0.1 = 1.43

* * *

REQUIRED WORK:

An eight man crew is to paint Building 29874 in Zone 8.

GDF ADJUSTMENT:

Craft Area:	Paint (Gen)
Crew Size:	M = multi-crew
Travel Zone:	Zone 8
GDF:	1.37
Crew size >6:	0.1

Adjusted GDF = 1.37 + 0.1= 1.47

* * *

REQUIRED WORK:

A three man crew is to mow the acreage in Zone 7 and is permitted to return to the shop for lunch.

GDF ADJUSTMENT:

Craft Area:	Roads & Grounds Labor
Crew Size:	M = multi-crew
Travel Zone:	Zone 7
GDF:	1.41
Return Lunch (Travel Zone 6-9):	0.2

Adjusted GDF = 1.41 + 0.2 = 1.61

F. ESTIMATED JOB TIME

As the "Building Blocks of Job Time" in Chapter VI illustrate, job estimates should contain sufficient time to complete all craft work required and allow time for job preparation, craft allowances, travel, and personal time.

1. Craft Data.

Craft data is the amount of actual craft working time required to accomplish a series of individual tasks in a work estimate. It is determined by selecting EPS tasks and multiplying the number of occurrences for each task by the task time standard.

2. Allowed Time.

When the EPS Craft Data is multiplied by the appropriate (and if necessary, adjusted) General Data Factor, the P/E determines the total EPS allowed time for the job.

3. Total Job Phase Time. When a work estimate contains non-EPS time determined from other work estimating data sources, this time is added to the EPS allowed time to arrive at the total job time for the estimate.

G. MATERIAL LISTING

After a Planner/Estimator has developed a work estimate, a Bill of Materials is needed. The Bill of Materials contains the list of supplies and materials the craftspersons will require to perform the work and serves as an order form to Supply.

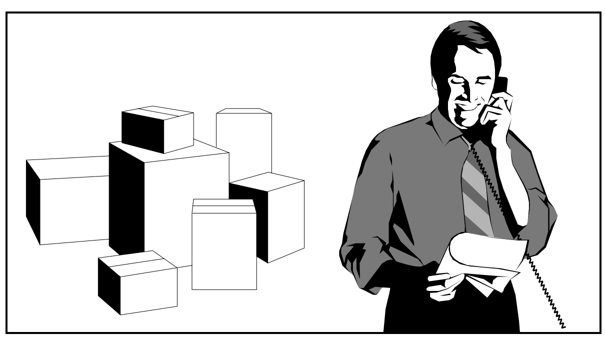
1. Identification.

When the Planner/Estimator makes a field visit to the work site prior to developing the estimate, the material required for the job should be considered. Notes related to material needs such as sizes, brands, colors, etc. are important when the materials must be ordered. In some instances, the customer should be consulted regarding various aspects of the material requirement (e.g. carpet color and style, wall colors, etc.).

2. Correct Material Quantities.

It is important for the Planner/Estimator to properly estimate material quantity requirements. Correct quantities of material enable the craftsperson to work the entire job without running out of materials. When they are forced to return to Supply or have to wait for additional materials to be ordered, productive craft time is lost.

3. Material Identification.



Planner/estimators deal in material nomenclature or noun names. Supply personnel deal in stock numbers. The ability of Supply to effectively support the Real Property operation, maintenance, and repair organization is directly affected by the degree of cooperation and interface between Supply and the planning and estimating organization. Planner/Estimators should do the required research of material stock numbers and maintain consistency in the nomenclature used to describe materials. Otherwise, Supply may be assigning multiple local stock numbers to the same item. This situation causes problems in stocking levels, as stock items are demand supported. In other words, in order to remain a stock item there must be a specific number of demands per year. When items are in the system by more than one number, there may not be sufficient demands to maintain the item in stock. The stock/supply catalog that Supply produces and estimators use for building BOMs is also affected. If items appear in several places under different names and stock numbers, it makes it difficult for the estimators to use the catalog with any degree of accuracy and it makes for a very large catalog.

4. Material Cost Sources.

If estimators are using commercial or local standards, the material costs should always be validated and adjusted as necessary. For example, R.S.Means™ indicates material cost on every line item. However, there is a city cost index in the back of each book which contains an adjustment factor to be applied to the material based on the geographic location of the work.

5. Bill of Materials (BOM).

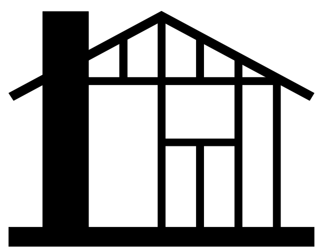
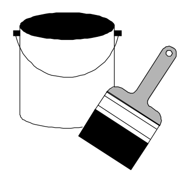
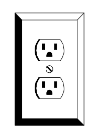
The bill of materials developed for each job should be as accurate as possible and contain sufficient information to allow Supply to pull from stock, order non stock items, and assemble the required items for a job.

CHAPTER VIII
WORK PHASING

In the facilities maintenance and repair work estimating process, job phasing is a critical element of the work planning activity. The definition of a phase is as follows:

> **PHASE**
> ***The amount of work that can be completed by one craft or work center without interruption from other crafts or work centers.***

Both construction and maintenance work must be separated into distinct job phases because the nature of both types of work prevent certain events from being accomplished before others are completed. For example, it is considerably more difficult for the electricians to run electrical wires after the wall board is hung than it is for them to do the work after the framing is in but before the carpenters return to hang the wall board. Similarly, it is easier for painters and makes for a neater job if the interior surfaces are painted before the electrical trim out is accomplished.

A. PHASING ADVANTAGES

As discussed in Chapter III, thorough work planning and proper work phasing provide some definite advantages within the facilities maintenance management system. These advantages include:

- **Efficient Estimating** — Work phasing provides the P/E with a sound method of breaking down the overall job into a logical work accomplishment sequence.

- **Effective Workload Scheduling** — Work phases are the basis of work scheduling.

- **Effective In-Shop Scheduling** — Phased jobs allow the shop foremen and shop planners (if assigned) to schedule shop personnel more efficiently and effectively and better coordinate the work accomplishment between shops involved in the job.

- **Enhanced Supply Support** — Supply support improves with properly phased estimates because Supply is better able to coordinate material requirements at the phase level as well as for the whole job. Materials can be staged by phase and by craft making it easier for each craft to obtain supplies they need at the right time.

- **More Detailed Job Costing** — Job costs can be accurately tracked and cost overruns more easily identified when they can be linked to a specific job phase.

- **Work Appraisal** — Reporting expenses for labor, materials, and equipment by phase allows for detailed analysis of the expenditure by craft, type of work, or product.

B. EPS JOB AND CRAFT PHASES

Work phasing is essential to proper EPS application. EPS views phases in terms of job phases and craft phases. The definitions are as follows:

JOB PHASE	CRAFT PHASE
The sequence of phases for work accomplishment.	***Sequence of phases in which a craft or work center appears at the job site to perform a job phase.***

Each phase requires application of the General Data Factor. It is important that the work be given the correct number of phases in a job estimate to ensure sufficient job preparation, travel, personal, and craft allowances based on craft time hours for the work.

EXAMPLE #1

REQUIRED WORK:

Construct and finish a wall in the middle of Room 300 dividing it into Room 300 and Room 301.

PHASING - TRADITIONAL SHOPS MAINTENANCE ORGANIZATION

JOB PHASE	CRAFT PHASE	CRAFT	DESCRIPTION
1	1	Carpenters	Fabricate & install framing
2	1	Electricians	Install electrical (rough in)
3	2	Carpenters	Install sheetrock wall
4	1	Painters	Paint new wall
5	2	Electricians	Finish electrical (trim out)

EXAMPLE #1 (cont.)

PHASING - MULTI-TRADE SHOPS MAINTENANCE ORGANIZATION

JOB PHASE	CRAFT PHASE	CRAFT	DESCRIPTION
1	1	Multi-trade	Install Wall - Fabricate & install framing - Install electrical (rough in) - Install sheetrock wall - Paint new wall - Finish electrical (trim out)

The multi-trade approach to accomplishing maintenance and repair work requirements must be taken into account when jobs are phased. Job phases should be based on the way shops perform work at individual locations.

EXAMPLE #2

REQUIRED WORK:

Paint an 8' x 12' wall with two coats semigloss enamel in Building #10, Room 200.

PHASING:

Because the painters will not experience interruptions by another craft (work center), this job appears to be a single phase job. However, the job is small. The painters will be delayed while the first coat of paint dries. Rather than remain idle at this job site, the painters will go to another job assignment and return later to complete this job. A second phase provides the job preparation time, craft allowance, and travel time necessary to return later and apply the second coat of paint.

JOB PHASE	CRAFT PHASE	CRAFT	DESCRIPTION
1	1	Painters	Paint first coat (let dry before second application)
2	2	Painters	Paint second coat

EXAMPLE #3

REQUIRED WORK:

Fabricate HVAC ductwork in the shop and install fabricated ductwork in Building #1015.

JOB PHASING:

The fact that the work is to take place in two locations must be considered. Work in Travel Zone 0, the Shop, to fabricate the duct work will be done first. Then the craftspersons must go to Building #1015 to perform the installation. Although no other craft will interrupt the work, a physical interruption in the job process divides a job into two phases. Job preparation and craft allowances will be needed to accomplish the work in the shop and additional job preparation, craft allowances, and travel time will be needed for the installation.

JOB PHASE	CRAFT PHASE	CRAFT	DESCRIPTION
1	1	Sheetmetal	Fabricate HVAC ductwork
2	2	Sheetmetal	Install HVAC ductwork

Job and craft phasing depend on the way in which the work will be performed by the shops. The number of different crafts used on a job and which crafts actually perform the work varies from installation to installation.

EXAMPLE #4

REQUIRED WORK:

Replace asphalt roof shingles on Building #664.

JOB PHASING:

Installation A

Assume: Carpenters are responsible for assembling and disassembling the scaffolding they require.

JOB PHASE	CRAFT PHASE	CRAFT	DESCRIPTION
1	1	Carpenters	Install scaffolding Remove & install shingles Remove scaffolding

EXAMPLE #4 (cont.)

Installation B

Assume: Riggers are responsible for all scaffolding work; roofers do all related roof work.

JOB PHASE	CRAFT PHASE	CRAFT	DESCRIPTION
1	1	Riggers	Install scaffolding
2	1	Carpenters	Replace shingle roof
3	2	Riggers	Remove scaffolding

Job phases must follow a logical work sequence. A job such as the one described above requiring repair to a plumbing line behind a wall should be phased so that work sequence follows the natural work flow of the project.

EXAMPLE #5

REQUIRED WORK:

Replace 20 square feet of sheetrock wall, replace 6 linear feet of ½" copper tubing water line and paint wall.

JOB PHASE		CRAFT PHASE	DESCRIPTION
Incorrect Phasing:	1 2 3	1-Carpenters 1-Plumbers 1-Painters	Remove & reinstall 20 SF of sheetrock wall Replace 6 LF of ½" copper tubing water line Paint wall
Correct Phasing:	1 2 3 4	1-Carpenters 1-Plumbers 2-Carpenters 1-Painters	Remove 20 SF of sheetrock wall Replace 6 LF of ½" copper tubing water line Install 20 SF of sheetrock wall Paint wall

After a job has been phased, each phase should be planned and estimated as if it were a separate and distinct job. In the correct phasing of the above job, an individual EPS estimated time will be determined for:

(1) removal of the damaged wall section
(2) repair or replacement of the water line
(3) replacement of the wall
(4) painting the wall

In this way, the job can be more effectively scheduled.

C. JOB PLANNING & ESTIMATING (JP&E) WORKSHEET

Job Planning & Estimating JP&E Worksheets are used to compute the total job time for each phase (EPS craft time, Universal Data, General Data, and Non-EPS time). Figure 8-1 is a sample JP&E Worksheet used to prepare a labor hour estimate for a job phase. The worksheet can be used for both EPS and Non-EPS estimates.

> **PHASE**
> ***Only one phase should be listed on a single JP&E Worksheet.***

The blocks of information for the JP&E worksheet are numbered in Figure 8-1 and described below.

1 **JOB REFERENCE NUMBER** — Work Request document number of the job for which the estimate is being prepared.

2 **SHOP** — Shop code or identification number of the shop or work center that will be performing work in the job phase.

3 **CRAFT** — Name of the craft within the shop that will be performing the work.

4 **CREW SIZE** — Number of crew members the Planner/Estimator thinks the shop foreman will assign to perform the work in the phase. Number of crew members determines whether single craftsperson or multi-crew GDF will be required.

5 **TRAVEL ZONE** — The Travel Zone is based on the Travel Zone Map location of the work site where the majority of work is to be performed. Travel Zone is used in determining the GDF to be applied.

6 **JOB PHASE NUMBER** — Sequence number of the phase in the entire job. This number may be assigned by the Lead Planner/Estimator after all the phases have been estimated.

7 **CRAFT PHASE NUMBER** — Sequence number of the phase for the craft performing the work.

8 **DATE PREPARED** — Date the estimate is prepared.

9 **WORK LOCATION** — Location where work is to be performed. If the location is not readily apparent, a map to help the craftsperson locate the work should be included with the job.

10 **JOB/CRAFT PHASE DESCRIPTION** — Description of the actual work to be performed in this phase. The description should contain the details such as sizes, quantities, types of material, special working conditions, coordination instructions, etc. that are required by shop personnel to complete the task.

JOB PLANNING & ESTIMATING WORKSHEET						1 JOB REFERENCE NUMBER 1
2 SHOP 2	3 CRAFT 3	4 CREW SIZE 4	5 TRAVEL ZONE 5	6 JOB PHASE NUMBER 6	7 CRAFT PHASE NUMBER 7	8 DATE PREPARED 8
9 WORK LOCATION 9						
10 JOB/CRAFT PHASE DESCRIPTION 1 0						

11 REFERENCE	12 TASK OR CHECKPOINT DESCRIPTION	13 UNIT OR CHECKPOINT HOURS (0.00000)	14 JOB OR OCCUR-RENCES (0.0)	15 EPS CRAFT HOURS (0.000)	16 NON EPS ESTIMATED CRAFT HOURS (0.000)
1 1	1 2	1 3	1 4	1 5	1 6

17/18	TOTAL CRAFT HOURS IN (0.000)	1 7	1 8
19/20	ALLOWED TIME (TOTAL EPS CRAFT HOURS x GDF OF [1 9]) IN (0.0)	2 0	
21	TOTAL NON EPS ESTIMATED HOURS IN (0.0)		2 1
22	TOTAL JOB PHASE TIME (ALLOWED TIME + NON EPS TIME) IN WHOLE HOURS		2 2
23	NUMBER OF TIMES OR CYCLES THE JOB IS TO BE PERFORMED		2 3
24	TOTAL LABOR HOUR REQUIREMENT (TOTAL JOB PHASE TIME x NUMBER OF CYCLES) ➡		2 4

Figure 8-1. Job Planning and Estimating (JP&E) Worksheet

11 **REFERENCE** — Reference number used to identify the standard. The number format will vary depending on the source.

12 **TASK/CHECKPOINT DESCRIPTION** — Concise detailed description of the actual work to be performed including size, quantity, material type, special working conditions, assumptions, calculations, Craft Time Adjustment usage and justification, etc.

13 **UNIT/CHECKPOINT HOURS** — The unit time for EPS or Non-EPS standard selected expressed in hours to 5 decimal places.

14 **JOB/OCCURRENCES** — Number of task occurrences or JOB SETUP occurrences.

15 **EPS CRAFT HOURS** — Block 13 x Block 14.

16 **NON-EPS ESTIMATED CRAFT HOURS** — Block 13 x Block 14.

17 **TOTAL CRAFT HOURS** — Total EPS craft time expressed in hours to 3 decimal places.

18 **TOTAL CRAFT HOURS** — Total Non-EPS craft time expressed in hours to 3 decimal places.

19 **GENERAL DATA FACTOR** — Value from the General Data Factor (GDF) sheet which provides time for job preparation, craft allowances, and travel to and from the job site.

20 **ALLOWED TIME** — Block 17 x Block 19 expressed in hours rounded up to the next highest tenth of an hour.

21 **TOTAL NON-EPS ESTIMATED HOURS** — Total Non-EPS time expressed in hours rounded up to the next highest tenth of an hour.

22 **TOTAL JOB PHASE TIME** — Block 20 + Block 21. It represents total time required to accomplish the job phase.

23 **NUMBER OF TIMES/CYCLES THE JOB IS TO BE PERFORMED** — Number of times the job is to be performed.

24 **TOTAL LABOR HOUR REQUIREMENT** — Block 22 x Block 23. It represents the total labor requirement for the job.

D. APPLICATION OF THE JP&E WORKSHEET

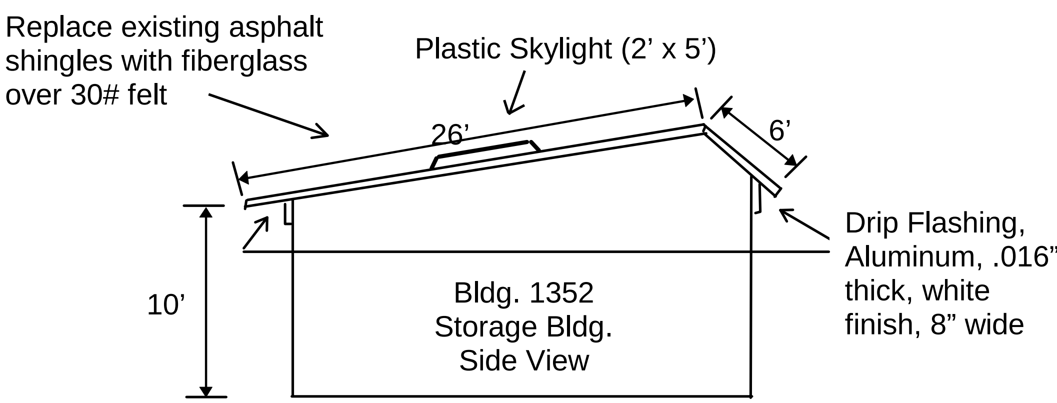
Steps for completing a JP&E Worksheet are shown in Figure 8-2 using the following example:

EXAMPLE

REQUIRED WORK:

Repair the roof on Building #1352 located in Travel Zone 4. Work requirements include:

- Remove old asphalt shingle roof and replace with fiberglass shingles on 30 pound felt
- Install a baked-on white enamel, aluminum drip edge, 0.016 thick by 8" wide over the 1" x 6" fascia along front and back of building
- Install 2' x 5' single plastic skylight in center of roof (rear face)



STEP *A* **: HEADINGS.**
Complete the information in the heading blocks 1-9.

STEP *B* **: JOB/CRAFT PHASE DESCRIPTION.**
Write a concise description of the work to be done.

STEP *C* **: TASK DESCRIPTIONS.**
Separate the tasks associated with the work requirements for the job phase and list them under the column 12. Include all known task requirements.

JOB PLANNING & ESTIMATING WORKSHEET						1 JOB REFERENCE NUMBER *JY 00013 4 J*
2 SHOP *Carp.*	3 CRAFT *Roof.*	4 CREW SIZE *3*	5 TRAVEL ZONE *4*	6 JOB PHASE NUMBER *1*	7 CRAFT PHASE NUMBER *1*	8 DATE PREPARED *1 SEPT 1994* A
9 WORK LOCATION *Bldg. 1352, Storage Building Roof*						

10 JOB/CRAFT PHASE DESCRIPTION *Remove asphalt shingles & install fiberglass shingles over 30 lb. felt.*
Install drip edge over fascia front and back.. Install 2' x 5' single plastic skylight in center of roof (rear face). B
Bldg. has sloped roof with 65' long x 32' wide of roof surface. All materials to be delivered to roof by vendor.

11 REFERENCE	12 TASK OR CHECKPOINT DESCRIPTION	13 UNIT OR CHECKPOINT HOURS (0.00000)	14 JOB OR OCCUR-RENCES (0.0)	15 EPS CRAFT HOURS (0.000)	16 NON-EPS ESTIMATED CRAFT HOURS (0.000)
CT 416	*Shingles, remove old & install new over 30 lb. felt.*	*.02152*	*2080.0*	*44.762*	
pg. 110	*Per SF.* C	F	G	H	I
D & E	*32' x 65' = 2080 SF*				
CT 408	*Shingles, install starter rows (2 rows)*	*.00532*	*130.0*	*0.692*	
pg. 110	*65' x 2 rows = 130 LF*				
CT 410	*Shingles, install ridge (per SF)*	*.01080*	*65.0*	*0.702*	
pg. 110	*Ridge shingle1' wide, 65 LF to cover)*				
PWA 005A	*AMH debris removal = 21 squares*	*.04000*	*95.0*	*3.800*	
	3 bdl. x 21 sq = 63 bdl x 50 lbs. = 3150 lbs.				
	3150 lbs. / 33.3 lb. per armload = 94.6 = 95 loads				
LAT-132	*Install drip edge, aluminum, .016" thick,*	*.13427*	*13.0*	*1.746*	
PG. 50	*8" girth, white finish, per LF*				
MEANS	*Install skylight , plastic, single, 2'x 5', per SF*	*.08100*	*10.0*		*.810*
078 101 0700					

17/18 TOTAL CRAFT HOURS IN (0.000)	J *51.702*	J *0.810*
19/20 ALLOWED TIME (TOTAL EPS CRAFT HOURS x GDF OF [*1.49*]) IN (0.0)	K *77.1*	
21 TOTAL NON-EPS ESTIMATED HOURS IN (0.0)		L *0.9*
22 TOTAL JOB PHASE TIME (ALLOWED TIME + NON-EPS TIME) IN WHOLE HOURS		M *78*
23 NUMBER OF TIMES OR CYCLES THE JOB IS TO BE PERFORMED		N *1*
24 TOTAL LABOR HOUR REQUIREMENT (TOTAL JOB PHASE TIME x NUMBER OF CYCLES) ➡		O *78*

Figure 8-2. Sample Estimate

STEP *D* : HANDBOOKS.

EPS HANDBOOKS

Select the appropriate EPS craft handbooks. For this example, they are the Carpentry Handbook, the Sheetmetal Handbook, and General Handbook. For each task, locate the Chapter in the handbook that appears to contain the task being described in Step C.

Carpentry Handbook:
360 ROOFING: Asphalt Shingles (Remove, Install, Replace)

Sheetmetal Handbook:
130 ROOFING: Components (Fabricate,Remove, Install, Replace)

Read the list of tasks in the chapter of each handbook to determine if there are tasks that parallel the work to be done in the job phase.

CT 416 SHINGLES: (Replace) 12" x 36" 5" exposure w/adhesive & INSTALL additional layer of felt.

CT 408 STARTER SHINGLES: (Install) 12" x 36" w/adhesive at eave.

CT 410 HIP RIDGE SHINGLES: (Install) 9" x 12" w/5" exposure.

LAT 132 ROOFING- COMPONENT (Install) Gravel Stop or Eave Drip Strip

Turn to the **EPS Task Time Standards — Descriptions and Unit Hours** to read the detailed description of each task being considered and obtain the task times for the standards selected.

The EPS General Handbook contains the standard for Additional Material Handling. This standard is located using the same technique used for the Carpentry and Sheetmetal standards.

PWA 005A Additional Material Handling

NON-EPS SOURCES

For the skylight installation a review of the Carpentry Handbook as well as the Sheetmetal Handbook shows that there is no EPS standard for this task. Review of the R.S.Means™ Repair and Remodeling Data, shows that this standards source does have a “listing” or “time value” for the task. Using accepted Means™ application techniques, the appropriate “value” or “task” should be selected.

MEANS™ 078 101 0700 *Skylight, plastic roof dome, 10 SF to 20 SF, single, per SF*

STEP *E* : REFERENCES.
Enter the references for the selected tasks and the page number on which they are located in Block 11 by the task time standard. For Non-EPS references use the source and reference number of the task selected (e.g. MEANS™ 078 101 0700).

STEP *F* : UNIT HOURS.
From the handbooks, enter task time standard unit hours into the Block 13.

Carpentry Handbook

CT 408 (page 110) *0.00532 hours per lin. ft. of shingles to install*

CT 410 (page 110) *0.01080 hours per sq. ft. of shingles to install*

CT 416 (page 110) *0.02152 hours per sq. ft. of shingles to replace*

Sheetmetal Handbook

LAT 132 (page 50) *0.13427 hours per section to install*

General Handbook

PWA 005A (page 7) *0.04000 hours per occurrence*

For Non-EPS sources look for the man-hours per unit and write the figure in Block 13. For Non-EPS local standards and other estimating information sources write the unit time if known, otherwise leave the column blank.

STEP *G* : JOB OR OCCURRENCES.

Determine the number of occurrences for those tasks selected. Each task description in Figure 8-2 shows the occurrence calculations based on the unit of measure. The number of occurrences for a task is written in Block 14.

OCCURRENCES

$$\frac{\text{Task Requirement}}{\text{EPS Task}} = \text{Occurrences}$$

STEP *H* : EPS CRAFT HOURS.

For each EPS task the Block 15 entry is the result of multiplying Block 13 x Block 14, expressed in hours to three decimal places rounded up.

Additional Material Handling Time = 0.04000 hours x 95 armloads = 3.800 craft hours

STEP *I* : NON-EPS ESTIMATED CRAFT HOURS.

For non EPS tasks, multiply Block 13 x Block 14 and express in hours to 3 decimal places in Block 16.

R.S. Means™ Standard 078 101 0700:
0.081 hours x 10.0 SF skylight = 0.810 hours

ROUNDING

Always round UP!

STEP *J* : TOTAL CRAFT HOURS.

Total the hours in the column under Blocks 15 and 16 and record the total in the respective columns of Blocks 17 and 18. If the estimate requires more than one JP&E Worksheet, subtotal each page placing the totals for the entire job on the last page in the respective columns of Blocks 17 and 18 in hours to three decimal places.

EPS Craft Hours = 44.762 + 0.692 + 0.702 + 3.800 + 1.746 = 51.702 hours
Non-EPS Craft Hours = 0.810 hours

STEP *K* : ALLOWED TIME.

Find the General Data Factor on the reverse side of the JP&E Worksheet and enter the GDF in Block 19. Then, multiply Block 17 x Block 19 to determine the allowed time which is recorded in Block 20 in hours to one decimal place rounded up.

General Data Factor = 1.49

1.49 x 51.702 = 77.1 hours allowed time

STEP *L* : TOTAL NON EPS ESTIMATED HOURS.

Total NON-EPS ESTIMATED CRAFT HOURS in the Block 18 are rounded up to whole hours to one decimal place and recorded in Block 21.

0.810 = 0.9 hours

STEP *M* : TOTAL JOB PHASE TIME.

Add Block 20 + Block 21 and record the total rounded up to the next whole hour in Block 22.

77.1 + 0.9 = 78 hours

TOTAL JOB PHASE TIME

Includes all time estimated to perform the work described in the phase. It includes both EPS and Non-EPS craft hours and all allowances and travel time required to perform the work.

STEP *N* : NUMBER OF TIMES OR CYCLES THE JOB IS TO BE PERFORMED.

Record the number of times the phase is to be performed or the number of preventive/ recurring maintenance cycles in Block 23.

This job is a one time repair project = 1 Time

STEP *O* : TOTAL LABOR HOUR REQUIREMENT.

Multiply Block 22 x Block 23 and record the hours in Block 24.

CHAPTER IX
WORK PACKAGE

After the Planner/Estimator develops the Job Planning and Estimating Worksheets for each phase of a job, a Work Package is assembled.

A. WORK PACKAGE CONTENTS

A complete Work Package generally contains the following documents:

WORK PACKAGE DOCUMENTS

Work Request
Job Estimating Summary
Job Phase Summary Sheet
Bill of Materials
Job Planning & Estimating Worksheet
Sketches/Drawings

.

To illustrate the documents in a Work Package, the example from Chapter 8 will be continued here.

EXAMPLE

REQUIRED WORK:
Remove asphalt shingles and install fiberglass shingles over 30 pound felt. Install drip edge over fascia front and back. Building has sloped roof with 65' x 32' of roof surface. Shingles and felt to be delivered to roof by vendor.

1. Work Request (Figure 9-1).

A Work Package contains the original Work Request. (When a scoping estimate is developed first, a copy of the scoping estimate is attached to the Work Package Work Request.)

2. Job Estimate and Cost Summary Sheet (Figure 9-2).

A brief description of the work, total hours by craft area, total labor cost, total material cost, total equipment cost, and total cost for each phase of the work is summarized on this sheet. (Labor, material, and equipment costs are based on the most current rates.) The grand

CUSTOMER REQUEST NAVFAC -9 -11014/TF -1 (REV. 4-75)	1.PRI	2. JOB ORDER NO. *0 0 0 1 3 4 J*	3. AMEND NO.	4. REQUEST NO. *J Y 1 3*

PART I - REQUEST *(By Customer)*

TO *PWD*	6. BRIEF TITLE *Reroof Bldg 1352*
5. FROM *DOL*	

7. TYPE OF SERVICE REQUESTED *(Check One)*

- [ ] SCOPING ESTIMATE
- [ ] FUNDABLE ESTIMATE ESTIMATED FUNDING DATE ____________
- [ ] MINOR WORK AUTHORIZATION M-____
- [ ] RECURRING ESTIMATE
- [ ] CONTRACT ESTIMATE
- [ ] ENGINEERING INVESTIGATION
- [X] SPECIAL PROJECT PREPARATION
- [ ] OTHER *(Specify)* ____________

8. FOR FURTHER INFORMATION CALL	9. PHONE	10. REQUESTOR *(Signature)*	11. DATE
R. L. Nellis	*X4767*	*R. L. Nellis*	*20 AUG 94*

12. PART II - DESCRIPTION OF PROBLEM/REQUIREMENT *(By Customer)*

The roof on Bldg. 1352 leaks in several places. This roof has been patched on several occasions over the past two years and continued to leak, damaging dry goods stored in the building.

Remove old shingle roof and felt down to the sheathing. Install new fiberglass shingles (brown) over new 30 lb. felt. Install skylight in center of roof (rear face).

Install new drip edge on fascia front and back.

13. STATEMENT OF CONSTRAINTS

Building is not scheduled for replacement until FY 2015.

14.

- [ ] SKETCH PLAN NO. ____________
- [ ] INVESTIGATION OR INSPECTION REPORT
- [ ] OTHER *(Identify)* ____________

Figure 9-1. Sample Work Request

JOB ESTIMATE AND COST SUMMARY	JOB REFERENCE NUMBER JY 00013 4 J
WORK LOCATION Bldg. 1352 (storage bldg.) roof - Zone 4	
CUSTOMER DOL/JY	SHORT JOB DESCRIPTION Remove old shingle roof

and replace with new shingle roof over 30 lb. felt. Install skylight in center of rear roof face. Install drip flashing on front and back of building.

JOB PHASE	CRAFT PHASE	WORK DESCRIPTION	CRAFT	LABOR HOURS	LABOR COST	MATERIAL COST	EQUIP. COST	TOTAL PHASE COST
1	1	Assemble scaffolding	Mov./ Rig.	7	130	0	10	140
2	1	Remove old roof and install new roof with skylight	Carp/ Roof	78	2041	992	60	3093
3	2	Disassemble scaffolding	Mov./ Rig.	7	130	0	10	140
NOTES		TOTALS		92	2301	992	80	3373
			CONTINGENCY 10 %					337
			OVERHEAD AND/OR SURCHARGE 9.8%					331
			GRAND TOTAL					4041

AUTHORIZED WORK TO BE PERFORMED (SIGNATURE)	TITLE	DATE
B. Johnson	PWO	4 SEP 94

Figure 9-2. Sample Job Estimate and Cost Summary Sheet

total cost of the job (with or without a contingency factor, as directed) and including overhead and/or surcharge is computed at the bottom.

3. Job Phase Summary Sheet(s) (Figure 9-3).

Each job phase, craft phase, phase description with all the details of the job, and labor hours from the JP&E Worksheet is summarized on the sheet. Job phases are listed in order of accomplishment. Since some organizations prefer not to give the shops the JP&E Worksheets, this sheet provides the work information needed for the shop to complete the job.

4. Bill of Materials (Figure 9-4).

A Bill of Materials for each job phase lists the materials and material quantities to be ordered and assembled for the job. This document is often used by Supply to order materials or check present stock to assure that material is available before the job is scheduled.

5. Job Planning & Estimating Worksheets (Figures 9-5 through 9-7).

The JP&E Worksheets, though not generally included in the copy of the Work Package sent to the shops, are included in the original Work Package. They provide the supporting detail for the job. They also help the Planner/Estimator discuss the estimate with shop foremen and other maintenance management personnel if the labor hours are questioned, and when variance analysis is performed.

6. Drawings/Sketches (Figure 9-8).

Engineering drawings or photo copies of building layouts, pictures of equipment to be installed, schematics, maps of exact locations, and mechanical, electrical, and structural system drawings are valuable aids to the Planner/Estimator during the development of the estimate and to craftspersons during the accomplishment of the job. If engineering drawings are not available, hand drawn sketches with accurate measurements are very helpful. At a minimum, include an overall layout of the work area to help reduce guesswork.

7. Other Pertinent Information.

Any information having to do with a job, other than that described above, that the Planner/Estimator finds valuable in developing the estimate including field notes can be included in the Work Package. Items such as equipment or manufacturers installation guidelines, material catalog data, test data, work clearance requests such as digging or hot work permits, change orders, and any background information pertinent to the Work Request should be included.

B. SUMMARY

The Work Package represents the job history from acceptance as a valid work requirement to close out. The documents discussed above are the start of the history. Because many jobs are estimated but remain unscheduled for extended periods of time, the Work Package described above provides the record of how the initial estimate was developed. Over time, changes in scope may occur, increasing or decreasing the requirements before the job can be scheduled. As changes are made the Work Package is modified. When the job is complete, the Work Package serves as the benchmark for variance analysis. Variance analysis results are added to the Work Package at the completion of the job.

JOB PHASE SUMMARY SHEET			JOB REFERENCE NUMBER *JY 00013 4 J*
JOB PHASE	CRAFT PHASE	DESCRIPTION	LABOR HOURS
1	*1*	*Assemble scaffolding*	*7*
	Mov./	*Description: Assemble pipe scaffolding 2 sections high x*	
	Rig.	*4 sections long along north front corner of Bldg. 1352*	
		in preparation for shingled roof replacement.	
2	*1*	*Replace shingle roof & install new drip flashing*	*78*
	Carp.	*Description: Remove old asphalt shingles on front & back*	
		faces of roof & install new 3-tab fiberglass shingles over	
		30 lb. felt. Total roof surface is 2080 SF (see enclosed	
		sketch for layout & dimensions). Sufficient starter, ridge, &	
		3-tab shingles and felt have been listed in the BOM to	
		include 10% waste. Install a 2' x 5" single plastic skylight	
		between trusses in center of roof (rear face). Use screws	
		provided with skylight and silicone adhesive/sealant for	
		installation. Vendor will deliver materials to roof. Install	
		8" wide x 0.016" thick aluminum drip edge over fascia	
		along front & rear of building. Remove debris upon	
		completion and place in on-site dumpster for scheduled	
		pickup.	
		NOTE: If sheathing has been damaged due to leakage,	
		notify Planning & Estimating for amendment.	
3	*2*	*Disassemble pipe scaffolding upon completion of*	*7*
	Move/	*roof replacement (8 sections of scaffolding).*	
	Rig.		
		Total Labor Hours:	*92*

1

Figure 9-3. Job Phase Summary Sheet

ACCOUNT CODE NO.	BILL OF MATERIALS FOR USE OF THIS FORM, SEE DA PAM 420-6; THE PROPONENT AGENCY IS OFFICE OF THE CHIEF OF ENGINEERS.			DATE 1 SEP 94	
PREPARED BY J. W. Lawson	DESIRED DELIVERY DATE 10 NOV 94			JOB ORDER NO. JY 00013 4 J	
DELIVER MATERIAL TO Bldg. 1352 roof top				WORK REQUEST NO. JY13	
STOCK OR PART NO.	DESCRIPTION OF ARTICLE	UNIT	QUANTITY	UNIT PRICE	TOTAL COST
5650-00-R01-1320	Shingle, 3 tab F/G 20 yr. Brown self sealing 3 bdl. per square (SQ) 2080 SF roof = 21 SQ Starter rows = 2 SQ Ridge cap = 1 SQ Waste = 2 SQ Total 26 SQ 26 SQ x 3 bdl = 78 bdl.	BDL	78	7.50	585.00
5650-00-R00-4706	Roofing felt, 30 lb. 1 roll covers 216 SF 2080 SF / 216 = 10 rolls + 1 extra 11 rolls	RL	11	14.37	158.07
5315-00-597-7793	Nail, roofing, 3/4" 50 lb. box	BX	1	75.00	75.00
5315-00-R01-1806	Nail, aluminum, flat head, 1 1/2" long, 1 lb. box	BX	2	6.50	13.00
	Flashing, drip edge, aluminum 0.016" thick, 8" wide white finish, 75 LF roll (ref. cost, Jones Bldg. Supply)	RL	2	14.00	28.00
	Skylight, plastic, single 2' x 5' (ref. cost Jones Bldg. supply.	EA	1	130.00	130.00
	Silicone adhesive/sealant, clear, 25 year, tube.	EA	1	3.00	3.00
	Phase 001 Total:				992.07

DA FORM 1 JUL 63 2702

Figure 9-4. Sample Bill of Materials

JOB PLANNING & ESTIMATING WORKSHEET						1 JOB REFERENCE NUMBER *JY 00013 4 J*
2 SHOP	3 CRAFT	4 CREW SIZE	5 TRAVEL ZONE	6 JOB PHASE NUMBER	7 CRAFT PHASE NUMBER	8 DATE PREPARED
Move/Rig.	*Move/Rig.*	*2*	*4*	*1*	*1*	*1 SEPT 1994*
9 WORK LOCATION *Bldg. 1352, Storage Building*						

10 JOB/CRAFT PHASE DESCRIPTION *Set up pipe scaffolding in preparation for replacing roof. Set up scaffolding at north front corner of building. 2 sections high x 4 sections long.*

11 REFERENCE	12 TASK OR CHECKPOINT DESCRIPTION	13 UNIT OR CHECKPOINT HOURS (0.00000)	14 JOB OR OCCUR-RENCES (0.0)	15 EPS CRAFT HOURS (0.000)	16 NON-EPS ESTIMATED CRAFT HOURS (0.000)
PWP 701A	*Assemble 4 sections of scaffolding (ground lvl)*	*0.33365*	*4*	*1.335*	
PWP 701A	*Assemble 4 sections of scaffolding (2nd tier)*	*0.32068*	*4*	*1.283*	
PWA 005A	*AMH for 8 sections of scaffolding*	*0.04000*	*32*	*1.280*	
	4 armloads per section x 8 sections = 32 loads				

17/18	TOTAL CRAFT HOURS IN (0.000)	*3.898*	*0.000*
19/20	ALLOWED TIME (TOTAL EPS CRAFT HOURS x GDF OF [*1.60*]) IN (0.0)	*6.3*	
21	TOTAL NON-EPS ESTIMATED HOURS IN (0.0)		*0.0*
22	TOTAL JOB PHASE TIME (ALLOWED TIME + NON-EPS TIME) IN WHOLE HOURS		*7*
23	NUMBER OF TIMES OR CYCLES THE JOB IS TO BE PERFORMED		*1*
24	TOTAL LABOR HOUR REQUIREMENT (TOTAL JOB PHASE TIME x NUMBER OF CYCLES) ➨		*7*

Figure 9-5. Sample Job Planning & Estimating Worksheet (Phase 1)

JOB PLANNING & ESTIMATING WORKSHEET						1 JOB REFERENCE NUMBER *JY 00013 4 J*
2 SHOP	3 CRAFT	4 CREW SIZE	5 TRAVEL ZONE	6 JOB PHASE NUMBER	7 CRAFT PHASE NUMBER	8 DATE PREPARED
Carp.	*Roof.*	*3*	*4*	*2*	*1*	*1 SEPT 1994*

9 WORK LOCATION *Bldg. 1352, Storage Building Roof*

10 JOB/CRAFT PHASE DESCRIPTION *Remove asphalt shingles & install fiberglass shingles over 30 lb. felt.*

Install drip edge over fascia front and back.. Install 2' x 5' single plastic skylight in center of roof (rear face).

Bldg. has sloped roof with 65' long x 32' wide of roof surface. All materials to be delivered to roof by vendor.

11 REFERENCE	12 TASK OR CHECKPOINT DESCRIPTION	13 UNIT OR CHECKPOINT HOURS (0.00000)	14 JOB OR OCCUR-RENCES (0.0)	15 EPS CRAFT HOURS (0.000)	16 NON-EPS ESTIMATED CRAFT HOURS (0.000)
CT 416	*Shingles, remove old & install new over 30 lb. felt.*	*.02152*	*2080.0*	*44.762*	
pg. 110	*Per SF.*				
	32' x 65' = 2080 SF				
CT 408	*Shingles, install starter rows (2 rows)*	*.00532*	*130.0*	*0.692*	
pg. 110	*65' x 2 rows = 130 LF*				
CT 410	*Shingles, install ridge (per SF)*	*.01080*	*65.0*	*0.702*	
pg. 110	*Ridge shingle1' wide, 65 LF to cover)*				
PWA 005A	*AMH debris removal = 21 squares*	*.04000*	*95.0*	*3.800*	
	3 bdl. x 21 sq = 63 bdl x 50 lbs. = 3150 lbs.				
	3150 lbs. / 33.3 lb. per armload = 94.6 = 95 loads				
LAT-132	*Install drip edge, aluminum, .016" thick,*	*.13427*	*13.0*	*1.746*	
PG. 50	*8" girth, white finish, per LF*				
MEANS	*Install skylight , plastic, single, 2'x 5', per SF*	*.08100*	*10.0*		*0.810*
078 101 0700					

17/18	TOTAL CRAFT HOURS IN (0.000)	*51.702*	*0.810*
19/20	ALLOWED TIME (TOTAL EPS CRAFT HOURS x GDF OF [*1.49*]) IN (0.0)	*77.1*	
21	TOTAL NON-EPS ESTIMATED HOURS IN (0.0)		*0.9*
22	TOTAL JOB PHASE TIME (ALLOWED TIME + NON-EPS TIME) IN WHOLE HOURS		*78*
23	NUMBER OF TIMES OR CYCLES THE JOB IS TO BE PERFORMED		*1*
24	TOTAL LABOR HOUR REQUIREMENT (TOTAL JOB PHASE TIME x NUMBER OF CYCLES) ➨		*78*

Figure 9-6. Sample Job Planning & Estimating Worksheet (Phase 2)

JOB PLANNING & ESTIMATING WORKSHEET						1 JOB REFERENCE NUMBER JY 00013 4 J
2 SHOP	3 CRAFT	4 CREW SIZE	5 TRAVEL ZONE	6 JOB PHASE NUMBER	7 CRAFT PHASE NUMBER	8 DATE PREPARED
Move/Rig.	*Move/Rig.*	*2*	*4*	*3*	*2*	*1 SEPT 1994*

9 WORK LOCATION *Bldg. 1352, Storage Building*

10 JOB/CRAFT PHASE DESCRIPTION *Disassemble and remove pipe scaffolding after roof replacement is complete. Scaffolding is 2 sections high x 4 sections long.*

11 REFERENCE	12 TASK OR CHECKPOINT DESCRIPTION	13 UNIT OR CHECKPOINT HOURS (0.00000)	14 JOB OR OCCUR-RENCES (0.0)	15 EPS CRAFT HOURS (0.000)	16 NON-EPS ESTIMATED CRAFT HOURS (0.000)
PWP 701A	*Disassemble 4 sections of scaffolding (ground lvl)*	*0.33365*	*4*	*1.335*	
PWP 701A	*Disassemble 4 sections of scaffolding (2nd tier)*	*0.32068*	*4*	*1.283*	
PWA 005A	*AMH for 8 sections of scaffolding*	*0.04000*	*32*	*1.280*	
	4 armloads per section x 8 sections = 32 loads				

17/18	TOTAL CRAFT HOURS IN (0.000)	*3.898*	*0.000*
19/20	ALLOWED TIME (TOTAL EPS CRAFT HOURS x GDF OF [*1.60*]) IN (0.0)	*6.3*	
21	TOTAL NON-EPS ESTIMATED HOURS IN (0.0)		*0.0*
22	TOTAL JOB PHASE TIME (ALLOWED TIME + NON-EPS TIME) IN WHOLE HOURS		*7*
23	NUMBER OF TIMES OR CYCLES THE JOB IS TO BE PERFORMED		*1*
24	TOTAL LABOR HOUR REQUIREMENT (TOTAL JOB PHASE TIME x NUMBER OF CYCLES) ➡		*7*

Figure 9-7. Sample Job Planning & Estimating Worksheet (Phase 3)

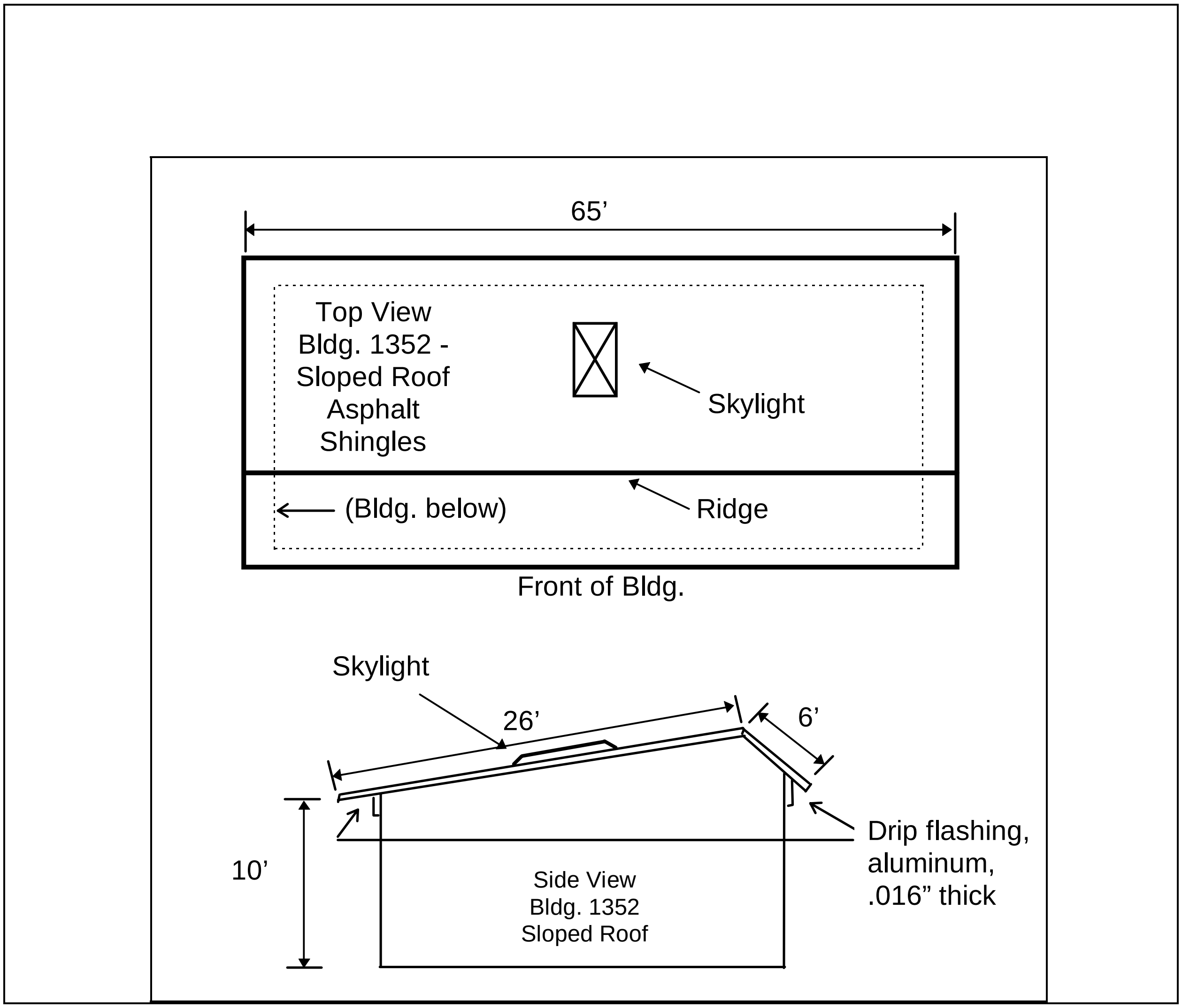


Figure 9-8. Sample Job Package Sketch

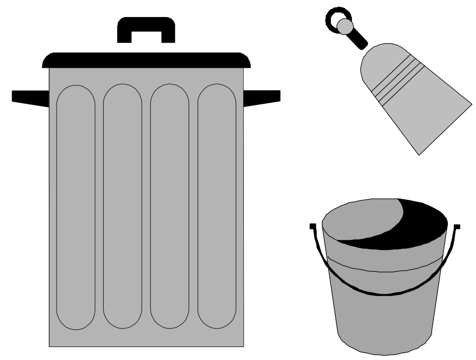
CHAPTER X
RECURRING MAINTENANCE PLANNING AND ESTIMATING

A. DEFINITION.

Recurring maintenance work is defined as follows:

RECURRING WORK

Maintenance work performed on a recurring basis which has strictly defined work content, does not encompass breakdown maintenance or repair, and is performed at repetitively scheduled frequencies.



Recurring maintenance work such as grounds maintenance, pest control, refuse collection or janitorial services can be part of an installation's facilities maintenance management program.

B. RECURRING WORK ESTIMATING ACTIVITIES.

To estimate a recurring work requirement, perform the following steps:

STEP #1: DETERMINE REQUIREMENTS.

SUBSTEP #1: Read the Work Request.
Recurring Work Requests may not change from year to year because the general requirement remains the same each year. The detail on this document may be limited or outdated. Therefore, the Planner/Estimator should verify the specific recurring work requirements associated with the job each year.

SUBSTEP #2: Talk to the Customer.
If the work to be performed is for a specific customer, the customer's point of contact should be contacted to verify the Work Request requirements and identify changes. Some customers have definite ideas about the work requirements, frequency of performance, and level of service they require.

SUBSTEP #3: Visit the Job Site.
Over a year, numerous changes may occur that effect the job site and requirements of a recurring job. A visit to the site allows the Planner/Estimator to determine if the work requirements have expanded, decreased, changed, or stayed the same.

SUBSTEP #4: Collect Related Job Information.
Specifications, site plans, manufacturer data, and other related information can greatly assist the Planner/Estimator in identifying all the requirements of a recurring job.

STEP #2. DEVELOP A WORK PLAN.

Work plans for recurring work are generally small because the work tends to be accomplished as a single phase job that is repeated on a cyclic basis over a specific period of time. Determining the period of performance and number of cycles is an important part of the recurring work planning process.

EXAMPLE

REQUIRED WORK:

Mow the field beside the main gate and the field located at the rear of the installation near the firing range. The mowing season is approximately five months of a year. Each requirement takes 50 hours per cycle.

FREQUENCY:

The table shows the effect frequency has on the annual labor requirement.

FREQUENCY	NUMBER OF TIMES/YEAR	TIME/SINGLE CYCLE	ANNUAL LABOR HOURS
Twice a week	43	50	2150
Weekly	22	50	1100
Every 2 weeks	11	50	550
Monthly	5	50	250

Because the field by the main gate is highly visible upon entering the installation, the frequency of the cuttings will be higher than the field at the back of the installation near the firing range. Deciding which frequency best meets the installation's requirements is directly connected to the resources available. Although cutting the field by the main gate two times a week may be the preferable frequency the economics of over a manyear of labor may be prohibitive. Likewise, the more remote field need only be cut every two weeks rather than weekly given its less visible location on the installation.

STEP #3: INTERFACE WITH SHOPS.

A meeting between the Planner/Estimator and the shop foreman after the work plan for a recurring job is developed allows the two to discuss the work requirements. The foreman may be aware of certain aspects of the work requirement the Planner/ Estimator may not have considered. The craftspersons performing the work in past years may have found that the frequency requirements for the level of service do not fit the work requirement. Special material requirements may also be needed to better accomplish the work.

STEP #4: DEVELOP THE JP&E WORKSHEET.

The substeps for completing a JP&E worksheet for recurring work are shown on Figure 10-1, based on the example following the figure.

JOB PLANNING & ESTIMATING WORKSHEET						1 JOB REFERENCE NUMBER AF 00017 4 S	
2 SHOP *Environ.*	3 CRAFT *Pest Cntl.*	4 CREW SIZE *1*	5 TRAVEL ZONE *4*	6 JOB PHASE NUMBER *1*	7 CRAFT PHASE NUMBER *1*	8 DATE PREPARED *1 SEPT 1994*	A
9 WORK LOCATION *Food service areas, west post*							

10 JOB/CRAFT PHASE DESCRIPTION *Provide monthly pest control service for food service operations at the bowling alley, snack bar, food court, and country store. Keys must be picked up at the retail manager's office.*

B

11 REFERENCE	12 TASK OR CHECKPOINT DESCRIPTION	13 UNIT OR CHECKPOINT HOURS (0.00000)	14 JOB OR OCCUR-RENCES (0.0)	15 EPS CRAFT HOURS (0.000)	16 NON-EPS ESTIMATED CRAFT HOURS (0.000)
QAT 014	*Pest control service for food service facilities:*	*0.02621*	*4*	*0.105*	
pg 49	*Bowling alley 1500 SF, 6 Appliances* C	F *(per job)*	G	H	
D & E	*Snack bar 2000 SF, 8 Appliances*	*0.00007*	*10,500*	*0.735*	
	Food court 6000 SF, 10 Appliances	*(per SF)*			
	Country store 1000 SF, 2 Appliances	*0.00800*	*26*	*0.208*	
	Total 10,500 SF, 26 Appliances	*(per appl.)*			
PWA 001	*Additional Work Location (3 AWL x 1 Crew)*	*0.070*	*3*	*0.210*	
Non-EPS	*Obtain keys from retail manager and return*	*0.100*	*1*		*0.100*
Local					I

17/18 TOTAL CRAFT HOURS IN (0.000)	J *1.258*	J *0.100*
19/20 ALLOWED TIME (TOTAL EPS CRAFT HOURS x GDF OF [*1.26*]) IN (0.0)	K *1.6*	
21 TOTAL NON-EPS ESTIMATED HOURS IN (0.0)		L *0.1*
22 TOTAL JOB PHASE TIME (ALLOWED TIME + NON-EPS TIME) IN WHOLE HOURS		M *2*
23 NUMBER OF TIMES OR CYCLES THE JOB IS TO BE PERFORMED		N *12*
24 TOTAL LABOR HOUR REQUIREMENT (TOTAL JOB PHASE TIME x NUMBER OF CYCLES) ➨		O *24*

Figure 10-1. JP&E Worksheet for a Recurring Maintenance Job

EXAMPLE

REQUIRED WORK:

> ***Provide monthly pest control service for food service operations at the bowling alley, snack bar, food court, and country store.***

SUBSTEP *A* : HEADINGS.
Complete the information in the heading Blocks 1-9.

SUBSTEP *B* : JOB/CRAFT PHASE DESCRIPTION.
Write a concise description of the work to be done in Block 10.

SUBSTEP *C* : TASK DESCRIPTIONS.
Separate the tasks associated with the work requirements for the job phase and list them under the TASK OR CHECKPOINT DESCRIPTION column (Block 12). Include all the known task requirements. All calculations used to support each task should be written on the JP&E Worksheet for future reference.

SUBSTEP *D* : HANDBOOKS.
Select the appropriate EPS craft handbooks. For this example, they are the Roads, Grounds, Pest Control & Refuse Collection Handbook and the General Handbook. For each task, locate the chapter in the handbook that appears to contain the task being described in Substep C.
230 PEST INSECT: Inside Housing(Control fleas, spiders, cockroaches etc.)

Read the list of tasks in the chapter to determine if there are tasks that parallel the work to be done in the job phase.
QAT 014 Provide pest control services for FOOD SERVICES facility

Turn to the **EPS Task Time Standards — Descriptions and Unit Hours** to read the detailed description of the task being considered and obtain the task time for the standard selected.

The EPS General Handbook contains the standards for the additional travel locations associated with moving from building to building to provide the pest control service.
PWA-1 Additional Work Location

For the Non-EPS requirement to obtain the keys, the Planner/Estimator must determine the time requirement based on information collected either during the site visit or from the shops.
Non-EPS Obtain keys form retail store manager's office

SUBSTEP *E* : REFERENCES.
Enter the reference for the selected task and the page number on which it is located in Block 11 by the task time standard. For Non-EPS references use the source and reference number of the task selected (e.g. Means™ 076 202 0200 or Local).

SUBSTEP *F* : UNIT HOURS.
From the handbook, enter task time standard unit hours into Block 13.

Roads, Grounds, Pest Control & Refuse Collection

QAT 014 (page 49)	*0.02621 hours per JOB SETUP TIME*
	0.00007 hours per square feet of food facility to treat
	0.00800 hours per appliances to provide pest control

General Handbook

PWA 001 (page 12)	*0.07000 hours per (persons per move) x (number of moves)*

The Non-EPS requirement is based on the Planner/Estimator determining the time needed.

Obtain the key from the retail manager's office *0.100 hours*

SUBSTEP *G* : JOB OR OCCURRENCES.
Determine the number of occurrences for the tasks selected. The task description in Figure 10-1 shows the occurrences calculations. The number of occurrences for the task are written in Block 14.

SUBSTEP *H* : EPS CRAFT HOURS.
For each EPS task the UNIT OR CHECKPOINT HOURS entry is the result of multiplying Block 13 x Block 14 expressed in hours to 3 decimal places rounded up in Block 15.

SUBSTEP *I* : NON-EPS ESTIMATED TIME.
For Non-EPS tasks multiply Block 13 x Block 14 and express in hours to 3 decimal places in Block 16.

SUBSTEP *J* : TOTAL CRAFT TIME.
Total the hours in the column under Blocks 15 and 16 and record the total in the respective columns of Blocks 17 and 18. If the estimate requires more than one JP&E Worksheet, subtotal each page placing the totals for the entire job on the last page in the respective columns of Blocks 17 and 18 in hours to 3 decimal places.
EPS craft Hours = 0.105 + 0.735 + 0.208 + 0.210 = 1.258 hours

SUBSTEP *K* : ALLOWED TIME.
Find the General Data Factor on the reverse side of the JP&E Worksheet and enter the GDF in Block 19. Then, multiply Block 17 x Block 19 to determine the allowed time which is recorded in Block 20 in hours to 1 decimal place rounded up.

SUBSTEP *L* : TOTAL NON-EPS ESTIMATED HOURS.
Total Non-EPS Estimated Craft Hours in Block 18 are rounded up to 1 decimal place and recorded in Block 21.
0.100 = 0.1

SUBSTEP *M* : TOTAL JOB PHASE TIME.
Add Block 20 + Block 21 and record the total rounded up to the next whole hour in Block 22.
1.6 + 0.1 = 2 hours

SUBSTEP *N* : NUMBER OF TIMES OR CYCLES THE JOB IS TO BE PERFORMED.
Record the number of recurring maintenance cycles in Block 23.
Monthly = 12 cycles

SUBSTEP *O* : TOTAL LABOR HOUR REQUIREMENT.
Multiply Block 22 x Block 23 and record the hours in Block 24.
2 x 12 = 24 hours

C. RECURRING MAINTENANCE WORK PACKAGE

Planner/Estimators are required to develop a complete work package for a recurring maintenance job. It should contain the same forms discussed in Chapter IX. All backup material used as part of the estimate development process needs to be included.

CHAPTER XI
PREVENTIVE MAINTENANCE INSPECTION (PMI) PLANNING AND ESTIMATING

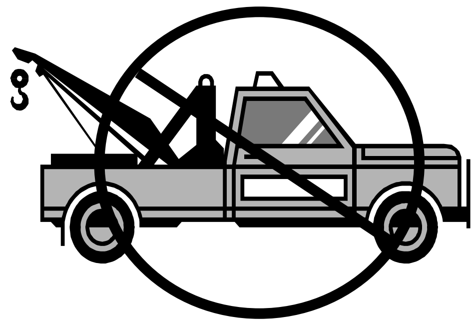
Engineered Performance Standards provide Planner/Estimators with a means of estimating preventive maintenance inspection requirements associated with dynamic and static equipment. A well planned, estimated, scheduled, and accomplished preventive maintenance program can reduce overall maintenance costs by decreasing the amount of repairs, replacements, and emergency responses to breakdowns that occur when equipment is not properly maintained.

A. DEFINITION.

PMI work is defined as follows:

PMI WORK

Planned, periodic maintenance work requirements for dynamic and static equipment that ensure the continued operation and extended life of a given piece of equipment by minimizing major repairs.



It has strictly defined work content which does not encompass breakdown maintenance or repair. It is performed on a recurring basis at easily scheduled specified frequencies.

EXAMPLES

Dynamic and static equipment on which PMIs are performed:

- HVAC equipment and systems
- Refrigeration systems
- Elevators
- Electrical and electronic systems
- Alarm systems
- Compressed air and gas distribution systems
- Overhead and sliding doors
- Airfield equipment
- Fire protection systems
- Weight handling equipment
- Kitchen and laundry equipment
- Swimming pool equipment
- POL transfer systems
- Fresh water treatment
- Storage and distribution systems
- Sewage treatment equipment
- Other electrical, pneumatic, or mechanical equipment and systems

B. PREVENTIVE MAINTENANCE INSPECTION WORK ESTIMATING ACTIVITIES.

PMI work planning activities are similar to recurring work discussed in Chapter X. The main difference being the PMI focus on machines and equip-ment rather than highly repetitive gene-ral recurring maintenance.

The following steps detail how to estimate PMI work.

STEP #1: DETERMINE REQUIREMENTS.

Identification of a PMI work requirement involves attention to small details. Preventive maintenance checkpoints on one machine may not be exactly the same as those on another. For example, one manufacturer may require that the bearings on a particular piece of equipment be routinely lubricated, while another has sealed bearings requiring no lubrication. Specific mechanical differences coupled with the different brands of similar equipment and machinery at an installation necessitate that the Planner/Estimator be thorough in the identification of work for inspection and preventive maintenance.

SUBSTEP #1: Visit the Job Site.

Site visits to validate and update PMI program inventory of equipment are essential to the development of a complete PMI estimate. Within a given year numerous changes can occur at a site. Equipment can be added, changed through repair, or removed. Sometimes the function of the facility in which the equipment is located changes, perhaps changing the level of service or frequency of the PMI.

PLANT OPERATIONS

Maintenance checks required on daily basis are considered a part of plant operations. They are generally performed as watchstander maintenance and are not considered PMI work requiring an estimate. (See Chapter XII.)

SUBSTEP #2: Collect Related Information.

Research of manufacturer literature and manuals helps to identify inspection and maintenance checkpoints and frequencies of service.

STEP #2. DEVELOP WORK PLAN.

PMI work plan development is more complex than recurring maintenance work plan development. PMI frequency requirements and logistical aspects of the work must be taken into account in the work plan.

SUBSTEP #1: Determine the PMI Frequencies

PMI work frequencies are based on the type of PMI work to be performed. Generally PMIs fall into one of two categories:

- **Repetitive PMI Requirements**

  Repetitive PMI requirements are performed on a regularly scheduled basis (i.e. weekly, monthly, quarterly, etc.). Often the work frequencies result in work requirement overlaps. Weekly requirements must be done 52 times a year. However weekly requirements should be done in conjunction with monthly requirements 12 times a year. Monthly requirements should be accomplished in conjunction with quarterly requirements 4 times a year, etc. By making the highest frequency the first phase and each lower frequency the following job phase, the lower frequency phases can be considered additional requirements that can be performed in conjunction with the higher frequency phases.

PMI FREQUENCIES

PMI work estimates that consist of combinations of frequencies require a job phase be developed for each frequency. Job Phase #1 should be the highest frequency requirement with each successive lower frequency the next phase.

- **Complex PMI Requirements**

Complex PMI requirements are simple in terms of determining the frequencies but difficult to plan. They include requirements for equipment certifications and overhauls that are based on a unit of measure other than a fixed interval of time or occur at intervals in excess of one year. PMIs can be required once every two, three, or more years or by numbers of hours of operation (e.g. every 2000 hours). Generally, these PMIs are single phase jobs. However, the burden is on the Planner/Estimator to determine the number of cycles required annually and estimate the job accordingly.

- **PMI Work Logistical Considerations**

PMI work plan development should include an analysis of logistical factors associated with work accomplishment.

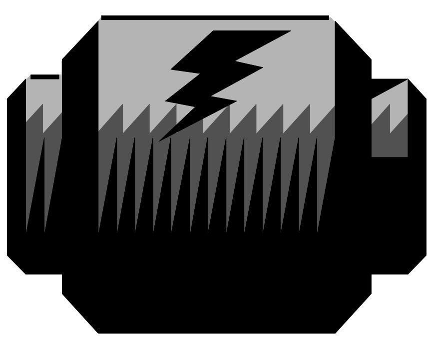
EXAMPLE

REQUIRED WORK:

PMI five Westinghouse generators including a ½ hour test run on each generator in Buildings N23, N24, N65, N32, and N84. (These buildings are within walking distance of one another.)

WORK PLAN DEVELOPMENT:

- Visit buildings to determine if the generators have similar maintenance requirements and are within walking distance.
- Determine if the test run requires the mechanic to stay with the generator throughout run period. If so, time must be added to the estimate for the test run of each generator.
- Determine if it is feasible for the mechanic to move from a running generator to other generators in the neighboring buildings. In that way, work can be accomplished while generators are being test run. If it appears that by moving from generator to generator the last generator will run its required period of time by the time the mechanic finishes the others, no time for waiting is required.



Geographic location of items of equipment in a PMI job should also be considered. Effective PMI work plan development includes considering the proximity of the items on which work is to be performed and adding to the job, as appropriate, additional work locations or additional round trips of travel to opposite direction zones to provide crew members with sufficient travel time.

STEP #3: INTERFACE WITH THE SHOPS

Because equipment is continually breaking down, requiring replacement, or simply being removed as facilities are changed, the PMI inventory is in a constant state of change. Effective PMI programs enable the shops to continually feed back field information about the equipment on the completed PMI checklists. Planner/Estimators should review shop field notes on equipment status, at a minimum, when an annual estimate is developed.

Meeting with the shop foreman or PMI mechanics to find out additional information about the maintenance and inspection checkpoints, the items of equipment, and the logistics of accomplishing the job can also prove helpful. In performing the work in past years, craftspersons may have found a better grouping of work site locations, be aware that some checkpoints are not essential to a piece of equipment and should be deleted from the list, or that the level of service should be changed due to the age of the equipment.

STEP #4: DEVELOP THE JP&E WORKSHEETS.

A typical multi-frequency PMI job is described below. The steps to estimate the job follow.

EXAMPLE

REQUIRED WORK:

Perform monthly, semi-annual, and annual PMI on (3) each 100 KW generators at the hospital -- 1 generator in the East machine room, 1 in the West machine room, and 1 at the rear of the hospital loading dock.

SUBSTEP #1: Develop JP&E Worksheet for Job Phase 1.

Figures 11-1 through 11-3 illustrate PMI job phase development steps.

STEP *A* : HEADINGS.

Complete the heading information in Blocks 1-9 of the JP&E Worksheet (Figure 11-1).

STEP *B* : JOB/CRAFT PHASE DESCRIPTION

Write a concise description of the work to be performed in Block 10 of the JP&E Worksheet.

STEP *C* : COMPLETE THE PMI CHECKLIST:

Locate the appropriate PMI checklist in the PMI handbook. Unlike the other craft handbooks, the PMI handbook does not contain EPS tasks. Instead, it is made up of EPS task operations which are compiled into PMI equipment checklists. This handbook is not

JOB PLANNING & ESTIMATING WORKSHEET						1 JOB REFERENCE NUMBER ZZ 01263 4 M	A
2 SHOP	3 CRAFT	4 CREW SIZE	5 TRAVEL ZONE	6 JOB PHASE NUMBER	7 CRAFT PHASE NUMBER	8 DATE PREPARED	
Electric	*Electric*	*1*	*3*	*1*	*1*	*15 SEPT 1994*	
9 WORK LOCATION *Main hospital complex*							

10 JOB/CRAFT PHASE DESCRIPTION *Perform monthly PM on 3 ea. 100 kw generators at the hospital: 1 generator in east machinery room, 1 generator in west machinery room, and 1 generator at the rear of hospital adjacent to the loading dock.*

B

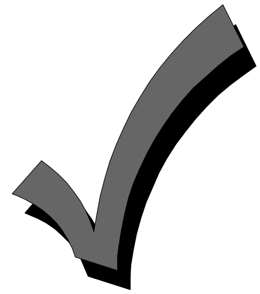
11 REFERENCE	12 TASK OR CHECKPOINT DESCRIPTION	13 UNIT OR CHECKPOINT HOURS (0.00000)	14 JOB OR OCCUR-RENCES (0.0)	15 EPS CRAFT HOURS (0.000)	16 NON-EPS ESTIMATED CRAFT HOURS (0.000)
PM/RM	*Monthly EPS PMI checks* C 5	*0.57500*	*3.0*	*1.725*	
35950					
PWA 001	*Additional work locations (2 AWL x 1 crew)*	*0.07000*	*2.0*	*0.140*	
	D				
CAT-D	*Check overspeed trip and alarm*	*0.09000*	*3.0*		*0.270*
398	D				

17/18 TOTAL CRAFT HOURS IN (0.000)	*1.865*	*0.270*
19/20 ALLOWED TIME (TOTAL EPS CRAFT HOURS x GDF OF [*1.28*]) IN (0.0)	*2.4*	
21 TOTAL NON-EPS ESTIMATED HOURS IN (0.0)		*0.3*
22 TOTAL JOB PHASE TIME (ALLOWED TIME + NON-EPS TIME) IN WHOLE HOURS		E *3*
23 NUMBER OF TIMES OR CYCLES THE JOB IS TO BE PERFORMED		F *10*
24 TOTAL LABOR HOUR REQUIREMENT (TOTAL JOB PHASE TIME x NUMBER OF CYCLES) ➨		G *30*

Figure 11-1. PMI Example Worksheet (Phase 1)

designed to serve as a preventive maintenance guide for various equipment brands or models, but is intended to present lists of related PMI checkpoints for generic types of equipment. Planner/Estimators can select checkpoints from the various checklists that are applicable to a specific item of equipment.

STEP *C 1* **: Locate the Appropriate Equipment Checklist.**
Use the PMI Handbook Table of Contents (Figure 11-2) to determine which checklist(s) to use.



EMERGENCY GENERATOR - GREATER THAN 15 KVA -
STANDARD NUMBER - 35950

The PMI Handbook checklist (Figure 11-3) is designed in worksheet format to reduce the Planner/Estimator effort transferring each checkpoint to a JP&E Worksheet. A reproduced copy allows a Planner/Estimator to record the number of occurrences of each checkpoint during a single cycle of a job, and to calculate total checkpoint hours and total EPS hours on the checklist. The checklist is made an attachment to the JP&E Worksheet.

STEP *C 2* **: Identify the Required Checkpoints.**
Not all the checkpoints on a checklist may be required for the job phase being developed. Additional checkpoints from other PMI worksheets in the handbook may also be needed along with Non-EPS checkpoints. Additional checkpoints and Non-EPS checkpoints are recorded on the JP&E Worksheet. (See STEP D.)

STEP *C 3* **: Determine the Number of Occurrences for Each Checkpoint Selected.**
Occurrences are determined by the number of times the craftsperson performs the checkpoint on a piece of equipment during one cycle of the job. When multiple pieces of equipment are to receive the same checkpoint, the number of pieces of equipment will be reflected as occurrences in Block 14 of the JP&E Worksheet.

PMI OCCURRENCES
The number of occurrences in the JP&E Worksheet reflects the number of pieces of equipment on which the PMI is performed.

STEP *C 4* **: Calculate Total Hours.**
Total hours are calculated by multiplying the number of occurrences of a checkpoint by the EPS HOURS to arrive at the TOTAL HOURS.

STEP *C 5* **: Calculate Total EPS Hours.**
Add the total hours in the Total Hours column. The total is placed at the bottom of the checklist in the space provided for TOTAL EPS HOURS. It is also recorded on the JP&E Worksheet as shown in Blocks 11 - 15.

TABLE OF CONTENTS (CONTINUED)

Figure 11-2. Sample PMI Handbook Table of Contents

STANDARD NUMBER - 35950 C1 PG. 166

EMERGENCY GENERATOR - GREATER THAN 15 KVA

Monthly PM, Hospital Generators *(1 of 3)*

CHECKPNT	CHECKPOINT DESCRIPTION C2	EPS HRS	OCC C3	TOT HRS C4
35951	CHECK CRANK CASE OIL LEVEL AND ADD OIL IF NEEDED	0.011	1	*0.011*
35952	CHECK RADIATOR WATER LEVEL AND ADD WATER AS NEEDED	0.009	*1*	*0.009*
35953	CHECK BATTERY WATER LEVEL AND ADD AS NEEDED; CHECK BATTERY FOR CORROSION AND CLEAN IF NEEDED	0.185	*1*	*0.185*
35954	TEST RUN GENERATOR FOR AND CHECK FOR PROPER OPERATION	0.318	*1*	*0.318*
35955	CHECK BELT FOR WEAR AND PROPER TENSION AND ADJUST	0.009		
35956	CHECK FUEL LEVEL IN UNDERGROUND TANK W/ GAGE POLE	0.035	*1*	*0.035*
35957	CHECK CONDITION OF AIR FILTER; REPLACE FILTER IF NEEDED	0.030		
35958	CHANGE DIESEL ENGINE OIL; AVERAGE 4 GALLONS	0.393		
35959	CHANGE GASOLINE ENGINE OIL; AVERAGE 5 GALLONS	0.172		
35960	REPLACE ENGINE OIL FILTER	0.045		
35961	CHECK SPARK PLUG IN INTERNAL COMBUSTION ENGINE PER PLUG; INCLUDES CHECK AND RESET GAP	0.027		
35962	CHECK WIRING, CONNECTIONS, SWITCHES, ETC., AND TIGHTEN LOOSE CONNECTIONS	0.092		
35963	WIPE DUST AND DIRT FROM ENGINE AND GENERATOR	0.084		
35964	CLEAN FLOOR AREA AROUND GENERATOR	0.051		
35965	FILL OUT MAINTENANCE RECORD/REPORT	0.017	*1*	*0.017*

TOTAL EPS HOURS C5 *0.575*

Figure 11-3. PMI Handbook Checklist (Phase 1)

STEP *D* : ADD ADDITIONAL EPS AND NON-EPS CHECKPOINTS
List additional EPS checkpoints found on other PMI checklists or in the craft handbooks on the JP&E Worksheet in Blocks 11 - 15 as appropriate.

PWA 001 (Page 12)   0.07000 x 2 occurrences x 0.140 hours

Non-EPS checkpoints are usually developed locally for specific equipment or systems found at the installation. Checkpoint sources include manufacturer's maintenance guides, equipment service and inspection guides, local requirements, and environmental regulations. PMI mechanics and shop foremen are another source of Non-EPS checkpoints. List Non-EPS checkpoints on the JP&E Worksheet in Blocks 11 - 16 as appropriate. The reference for a Non-EPS standard should provide information related to the source of the data. For the following checkpoint, the CAT-D398 indicates that the manufacturer's catalogue for diesel generators was the source of the checkpoint.

CAT-D398 Check overspeed trip and alarm
0.09000 hours x 3 occurrences = 0.270 hours

STEP *E* : DETERMINE THE TOTAL JOB PHASE TIME.
Complete Blocks 17 through 22 of the JP&E Worksheet.

STEP *F* : DETERMINE THE NUMBER OF PHASE CYCLES.
Calculate the number of phase cycles using the following formula. The number of cycles for the current PMI phase equals the "usual" number of cycles for the current PMI frequency phase, minus the "usual" number of cycles for the next highest frequency phase (i.e. the PMI frequency to be developed in the next phase).The result is the actual number of cycles the current job phase must be performed during the year. The following calculation determines the "actual" number of cycles for Phase 1.

PMI CYCLE FORMULA

"Usual" No. of Cycles (Current Phase)
– "Usual" No. of Cycles (Next Phase*)
"Actual" No. of Cycles (Current Phase)

****Next phase is the next highest frequency phase for the PMI job.***

"Usual" Monthly Cycles (Phase 1)	*= 12 Cycles*
– "Usual" Semi-Annual Cycles (Phase 2)	*= 2 Cycles*
"Actual" Monthly Cycles (Phase 1)	*= 10 Cycles*

When calculating the number of Phase 1 (monthly) cycles, the *next highest frequency* requirement is semi-annual (which will be developed as Phase 2). The number of cycles for the phase are recorded in Block 23.

STEP *G* : CALCULATE THE TOTAL LABOR HOUR REQUIREMENT
Multiply Block 22 x Block 23 and record in Block 24.
3 hours x 10 cycles = 30 hours

SUBSTEP #2: Develop JP&E Worksheet For Job Phase 2.

The steps to develop the JP&E Worksheet for Job Phase 2 are identical to those for Job Phase 1. However, the Planner/Estimator must also:

- add checkpoints associated with semi-annual PMI
- change the number of cycles

Figures 11-4 and 11-5 show the completed forms with the changes highlighted.

PHASE 2 CYCLES	
"Usual" Semi-Annual Cycles (Phase 2)	**= 2 Cycles**
– "Usual" Annual Cycles (Phase 3)	**= 1 Cycle**
"Actual" Semi-Annual Cycles (Phase 2)	**= 1 Cycle**

SUBSTEP #3: Develop JP&E Worksheet For Job Phase 3.

The steps to develop the JP&E Worksheet for Job Phase 3 are identical to those for Job Phases 1 and 2. However the Planner/Estimator must also:

- add EPS checkpoints associated with the annual PMI
- add one additional Non-EPS checkpoint
- add additional material handling for the handling of the oil to and from the job
- change the number of cycles
- change the crew size from 1 to 2 craftspersons due to the addition of the oil changing requirement. (During the work plan development step, the shop foreman indicated that a helper is sent with the mechanic to perform the oil changes.)

Figures 11-6 and 11-7 show the completed forms with the changes for the annual requirement highlighted.

PHASE 3 CYCLES	
"Usual" Annual Cycles (Phase 3)	**= 1 Cycle**
– No Additional Phases	**= 0 Cycles**
"Actual" Annual Cycles (Phase 3)	**= 1 Cycle**

SUBSTEP #4. Compute Annual Labor Estimate.

Once each PMI frequency job phase has been estimated, the TOTAL LABOR HOUR REQUIREMENT for each phase is transferred to a JOB ESTIMATE and COST SUMMARY sheet. (See Figure 11-8.) The annual estimate is determined by calculating the labor cost, material cost, and equipment cost, adding any applicable contingency fees and overhead/surcharge and coming up with a GRAND TOTAL for the job.

JOB PLANNING & ESTIMATING WORKSHEET						1 JOB REFERENCE NUMBER ZZ 01263 4 M	A
2 SHOP Electric	3 CRAFT Electric	4 CREW SIZE 1	5 TRAVEL ZONE 3	6 JOB PHASE NUMBER 2	7 CRAFT PHASE NUMBER 2	8 DATE PREPARED 15 SEPT 1994	
9 WORK LOCATION Main hospital complex							

10 JOB/CRAFT PHASE DESCRIPTION *Perform semi-annual PM on 3 ea. 100 kw generators at the hospital: 1 generator in east machinery room, 1 generator in west machinery room, and 1 generator at the rear of hospital adjacent to the loading dock.*

B

11 REFERENCE	12 TASK OR CHECKPOINT DESCRIPTION	13 UNIT OR CHECKPOINT HOURS (0.00000)	14 JOB OR OCCUR-RENCES (0.0)	15 EPS CRAFT HOURS (0.000)	16 NON-EPS ESTIMATED CRAFT HOURS (0.000)
PM/RM	Semi-annual EPS PMI checks C 5	0.706	3.0	2.118	
35950					
PWA 001	Additional work locations (2 AWL x 1 crew)	0.07000	2.0	0.140	
	D				
CAT-D	Check overspeed trip and alarm	0.09000	3.0		0.270
398	D				

17/18	TOTAL CRAFT HOURS IN (0.000)	2.258	0.270
19/20	ALLOWED TIME (TOTAL EPS CRAFT HOURS x GDF OF [1.28]) IN (0.0)	2.9	
21	TOTAL NON-EPS ESTIMATED HOURS IN (0.0)		0.3
22	TOTAL JOB PHASE TIME (ALLOWED TIME + NON-EPS TIME) IN WHOLE HOURS		E 4
23	NUMBER OF TIMES OR CYCLES THE JOB IS TO BE PERFORMED		F 1
24	TOTAL LABOR HOUR REQUIREMENT (TOTAL JOB PHASE TIME x NUMBER OF CYCLES) ➨		G 4

Figure 11-4. PMI Example Worksheet (Phase 2)

STANDARD NUMBER - 35950 PG. 166

EMERGENCY GENERATOR - GREATER THAN 15 KVA

Semi-Annual PM, Hospital Generators (2 of 3)

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
35951	CHECK CRANK CASE OIL LEVEL AND ADD OIL IF NEEDED	0.011	*1*	*0.011*
35952	CHECK RADIATOR WATER LEVEL AND ADD WATER AS NEEDED	0.009	1	*0.009*
35953	CHECK BATTERY WATER LEVEL AND ADD AS NEEDED; CHECK BATTERY FOR CORROSION AND CLEAN IF NEEDED	0.185	*1*	*0.185*
35954	TEST RUN GENERATOR FOR AND CHECK FOR PROPER OPERATION	0.318	*1*	*0.318*
35955	CHECK BELT FOR WEAR AND PROPER TENSION AND ADJUST AS NEEDED	0.009	*1*	*0.009*
35956	CHECK FUEL LEVEL IN UNDERGROUND TANK WITH GAGE POLE	0.035	*1*	*0.035*
35957	CHECK CONDITION OF AIR FILTER; REPLACE FILTER IF NEEDED	0.030	*1*	*0.030*
35958	CHANGE DIESEL ENGINE OIL; AVERAGE 4 GALLONS	0.393		
35959	CHANGE GASOLINE ENGINE OIL; AVERAGE 5 GALLONS	0.172		
35960	REPLACE ENGINE OIL FILTER	0.045		
35961	CHECK SPARK PLUG IN INTERNAL COMBUSTION ENGINE PER PLUG; INCLUDES CHECK AND RESET GAP	0.027		
35962	CHECK WIRING, CONNECTIONS, SWITCHES, ETC., AND TIGHTEN LOOSE CONNECTIONS	0.092	*1*	*0.092*
35963	WIPE DUST AND DIRT FROM ENGINE AND GENERATOR	0.084		
35964	CLEAN FLOOR AREA AROUND GENERATOR	0.051		
35965	FILL OUT MAINTENANCE RECORD/REPORT	0.017	*1*	*0.017*

TOTAL EPS HOURS *0.706*

Figure 11-5. PMI Handbook Checklist (Phase 2)

JOB PLANNING & ESTIMATING WORKSHEET						1 JOB REFERENCE NUMBER ZZ 01263 4 M	A
2 SHOP Electric	3 CRAFT Electric	4 CREW SIZE 2	5 TRAVEL ZONE 3	6 JOB PHASE NUMBER 3	7 CRAFT PHASE NUMBER 3	8 DATE PREPARED 15 SEPT 1994	
9 WORK LOCATION Main hospital complex							
10 JOB/CRAFT PHASE DESCRIPTION Perform annual PM on 3 ea. 100 kw generators at the hospital: 1 generator in east machinery room, 1 generator in west machinery room, and 1 generator at the rear of hospital adjacent to the loading dock.							
B							

11 REFERENCE	12 TASK OR CHECKPOINT DESCRIPTION	13 UNIT OR CHECKPOINT HOURS (0.00000)	14 JOB OR OCCUR-RENCES (0.0)	15 EPS CRAFT HOURS (0.000)	16 NON-EPS ESTIMATED CRAFT HOURS (0.000)
PM/RM	Annual EPS PMI checks C 5	1.27900	3.0	3.837	
35950					
PWA 001	Additional work locations (2 AWL x 2 crew)	0.07000	4.0	0.280	
	D				
CAT-D	Check overspeed trip and alarm	0.09000	3.0		0.270
398	D				
PWA 005A	AMH engine oil	0.04000	12	0.480	
	4 gal. = 2 armloads x 3 engines = 6				
	4 gal. waste oil x 3 engines = 6				
	6 + 6 = 12				
	D				
CAT-D	Bleed injectors, 6 per engine	0.02500	18		0.450
398A	6 injectors x 3 engines = 18 injectors				
	D				

17/18	TOTAL CRAFT HOURS IN (0.000)	4.597	0.720
19/20	ALLOWED TIME (TOTAL EPS CRAFT HOURS x GDF OF [1.33]) IN (0.0)	6.2	
21	TOTAL NON-EPS ESTIMATED HOURS IN (0.0)		0.8
22	TOTAL JOB PHASE TIME (ALLOWED TIME + NON-EPS TIME) IN WHOLE HOURS		E 7
23	NUMBER OF TIMES OR CYCLES THE JOB IS TO BE PERFORMED		F 1
24	TOTAL LABOR HOUR REQUIREMENT (TOTAL JOB PHASE TIME x NUMBER OF CYCLES) ➡		G 7

Figure 11-6. PMI Example Worksheet (Phase 3)

EMERGENCY GENERATOR - GREATER THAN 15 KVA

Annual PM, Hospital Generators *(3 of 3)*

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
35951	CHECK CRANK CASE OIL LEVEL AND ADD OIL IF NEEDED	0.011	*1*	*0.011*
35952	CHECK RADIATOR WATER LEVEL AND ADD WATER AS NEEDED	0.009	*1*	*0.009*
35953	CHECK BATTERY WATER LEVEL AND ADD AS NEEDED; CHECK BATTERY FOR CORROSION AND CLEAN IF NEEDED	0.185	*1*	*0.185*
35954	TEST RUN GENERATOR FOR AND CHECK FOR PROPER OPERATION	0.318	*1*	*0.318*
35955	CHECK BELT FOR WEAR AND PROPER TENSION AND ADJUST AS NEEDED	0.009	*1*	*0.009*
35956	CHECK FUEL LEVEL IN UNDERGROUND TANK WITH GAGE POLE	0.035	*1*	*0.035*
35957	CHECK CONDITION OF AIR FILTER; REPLACE FILTER IF NEEDED	0.030	*1*	*0.030*
35958	CHANGE DIESEL ENGINE OIL; AVERAGE 4 GALLONS	0.393	*1*	*0.393*
35959	CHANGE GASOLINE ENGINE OIL; AVERAGE 5 GALLONS	0.172	___	________
35960	REPLACE ENGINE OIL FILTER	0.045	*1*	*0.045*
35961	CHECK SPARK PLUG IN INTERNAL COMBUSTION ENGINE PER PLUG; INCLUDES CHECK AND RESET GAP	0.027	___	________
35962	CHECK WIRING, CONNECTIONS, SWITCHES, ETC., AND TIGHTEN LOOSE CONNECTIONS	0.092	*1*	*0.092*
35963	WIPE DUST AND DIRT FROM ENGINE AND GENERATOR	0.084	*1*	*0.084*
35964	CLEAN FLOOR AREA AROUND GENERATOR	0.051	*1*	*0.051*
35965	FILL OUT MAINTENANCE RECORD/REPORT	0.017	*1*	*0.017*

TOTAL EPS HOURS *1.279*

Figure 11-7. PMI Handbook Checklist (Phase 3)

JOB ESTIMATE AND COST SUMMARY	JOB REFERENCE NUMBER
Hospital Generator PMI	*ZZ 01263 4 M*

WORK LOCATION *Main Hospital Complex*

CUSTOMER	SHORT JOB DESCRIPTION
MEDCEN	*Perform monthly, semi-annual,*

and annual PMI on 3 each 100 kw emergency generators during FY95

JOB PHASE	CRAFT PHASE	WORK DESCRIPTION	CRAFT	LABOR HOURS	LABOR COST	MATL. COST	EQUIP. COST	TOTAL PHASE COST
1	1	Monthly PMI	ELE	30	960		60	1020
2	2	Semi-Annual PMI	ELE	4	128		10	138
3	3	Annual PMI	ELE	7	224	40	9	273

NOTES

TOTALS	41	1312	40	79	1431
CONTINGENCY %					-
OVERHEAD AND/OR SURCHARGE					-
GRAND TOTAL					1431

AUTHORIZED WORK TO BE PERFORMED (SIGNATURE)	TITLE	DATE
John H. Abbot	*Director of Public Works*	*21 Sept 94*

Figure 11-8. Job Estimate and Cost Summary Sheet

CHAPTER XII
WATCHSTANDING/PLANT OPERATIONS
PLANNING AND ESTIMATING

A. DEFINITION.

Watchstanding/plant operations work is defined as:

WATCHSTANDING/PLANT OPERATIONS

Routine operator maintenance, inspection, and observation performed on a recurring basis throughout scheduled blocks of time during a specified period of time (e.g. hours, shift, day)

Watchstanding/plant operation work requirements are based on the functions of the system, machinery, or watchstanding requirement and the related requirements and restrictions associated with it. Many of the work requirements have a direct impact of the labor hour estimate.

EXAMPLES

Watchstanding/plant operations at an installation include:

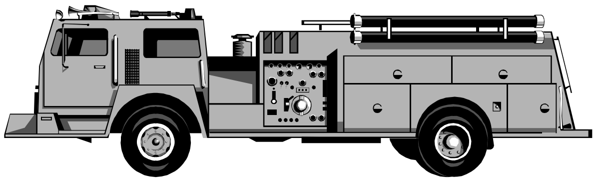
- ***Boiler and heating plant operation***
- ***Water treatment and sewage plant operation***
- ***Fire departments***
- ***Steam plants***
- ***Refrigeration and gas generating plants***
- ***Security alarm systems***
- ***Environmental control systems***
- ***Security guard requirements***

- **Regulatory and Permit Restrictions.**

Regulatory and permit restrictions generate watchstanding/plant operations requirements.

EXAMPLES

OPERATION	REQUIREMENT
Waste Water Treatment Facility	At least one licensed waste water treatment technician on duty during plant operations
Boiler and Large Cooling Systems	Round the clock monitoring and testing to assure no pollutants are emitted or explosions occur
Fire Department	Strict manning requirements for fire suppression equipment response



• Checkpoints.

Work requirements associated with the operation of a system, plant, or continuous service function are broken down into checkpoints performed on a periodic basis throughout a specific block of time. Checkpoint requirements are considered a part of a worker's normal tour of duty. However, the magnitude of work associated with the requirement and the frequency of the requirement have a direct effect on labor requirements for the estimate.

EXAMPLE

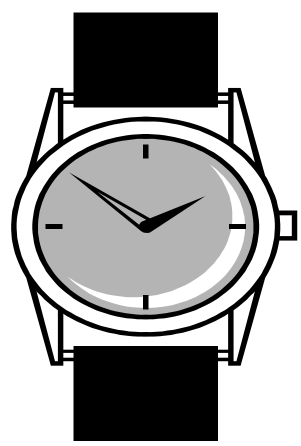
REQUIRED WORK:

8 water treatment pumping systems require a series of chemical tests daily. The tests and subsequent analysis of the results takes 1 hour per system.

LABOR REQUIREMENT:

The required tests will require one plant operator devoted solely to conducting the tests during an 8 hour period. Additional watchstanding/plant operations personnel will be required to perform the other work requirements associated with the systems operation.

B. ROVING MECHANICAL REQUIREMENTS



Watchstanding/plant operation requirements are not necessarily stationary requirements. Many are done on a roving mechanical tour basis. Systems that do not require around the clock, nonstop operator attendance, but do require monitoring of system indicators over a given time period, fall into this type of watchstanding/plant operation work requirement. Examples of such systems include electrical switch stations and sewage lift stations. Although some installations have replaced the roving worker with automated environmental and security control systems monitored from central control consoles, the console monitor represents a watchstanding requirement that must be estimated to ensure that the station is continuously monitored.

C. JP&E WORKSHEET DEVELOPMENT

The JP&E Worksheet is used to develop watchstanding/plant operation estimates. The Planner/Estimator should utilize EPS data for checkpoints or work requirements covered by EPS and other sources of standards and estimating information as applicable to determine the labor requirements within a fixed shift.

D. WATCHSTANDING / PLANT OPERATIONS WORK PACKAGE

Watchstanding/Plant Operations work packages contain the same forms as described in Chapter IX.

BREAKDOWN REPAIRS

Do not include time for breakdown and repair maintenance in watchstanding/plant operations estimates. Breakdown and repair maintenance associated with these systems should be documented on a separate Work Requests and Service Calls so that an accurate records of system repair workload are maintained.

APPENDIX A

CLASS EXERCISE WORKBOOK

CLASS EXERCISE WORKBOOK

This appendix is designed to aid in training for the Work Estimating Course and supports the methods and techniques discussed in Chapters 1 through 12 of the Work Estimating Desk Guide. The quizzes and exercises included in this workbook have been designed to provide Planner/Estimators with practice opportunity to estimate labor hour requirements for craftspersons to perform typical facilities maintenance tasks.

The Class Exercise Workbook contains the following exercise materials:

- Quizzes covering the overview, background, and general information presented in the Work Estimating Desk Guide
- Engineered Performance Standards (EPS) Lookup Exercises
- Single Phase / Single Craft Problems
- Multi-Phase / Multi-Craft Problems
- Recurring Maintenance / Services Problems
- Preventive Maintenance Problems

CHAPTERS 1 & 2
FACILITIES MAINTENANCE MANAGEMENT

1. Facility Maintenance Management objectives include:

   a. Provide proper and consistent levels of maintenance.
   b. Increase work force productivity.
   c. Provide appropriate response to customer requirements.
   d. All of the above

2. Which of the following is not a component of the Maintenance Management System?

   a. Work Generation
   b. Work Control
   c. Equipment Maintenance
   d. Appraisal

3. The most reactive type of RPMA work is:

   a. PMI
   b. Service Work
   c. Plant Operations/Watch Standing
   d. Scheduled Pest Control

4. Work that can be effectively planned & scheduled:

   a. PMI
   b. Recurring work
   c. Plant Operations and Watch Standing
   d. All of the above

5. Work is generated by:

   a. Scheduled & Command Inspections
   b. Work Requests and Service Calls
   c. Standing & Recurring Work Orders
   d. All of the above

CHAPTER 3
WORK ESTIMATING

1. Which Estimate type contains the most detail:

   a. Scoping/Desktop
   b. Inspection Estimate
   c. Funded Estimate
   d. Detailed Estimate

2. Site Visits are made by Planner-Estimators to:

   a. Determine exact scope
   b. Perform Material Type and Quantity Validations
   c. Determine unusual site conditions
   d. All of the above

3. Preliminary estimating activities do not include:

   a. Verify the work requirement
   b. Develop the bill of materials
   c. Develop the rough job plan
   d. Interface with the shops

4. Estimating activities include:

   a. Identifying the work standards
   b. Developing concise phase descriptions and sketches
   c. Developing the Bill of Materials
   d. All of the above

5. Detailed Estimates should have an accuracy of:

   a. +/- 10%
   b. +/- 20%
   c. +/- 30%
   d. +/- 40%

CHAPTER 4
SOURCES OF ESTIMATING DATA

1. Which of the following is (are) the most accurate estimating source?

    a. Historical Information on actual jobs
    b. Experience
    c. Contract data on actual jobs
    d. Standards

2. Which of the following are best suited for new construction?

    a. Engineered Performance Standards (EPS)
    b. Means™ Construction Cost Data
    c. Walkers™ Building Estimator's Reference Book
    d. Both b and c

3. Which of the following are best suited for estimating maintenance & repair?

    a. Engineered Performance Standards (EPS)
    b. Means™ Construction Cost Data
    c. Walkers™ Building Estimator's Reference Book
    d. All of the above

4. Which of the following are "public domain" estimating sources?

    a. Facility Engineer Job Estimating (FEJE) system
    b. MCACES
    c. Paver, Roofer and Tracker
    d. All of the above

5. Standards are:

    a. A benchmark for a defined amount of work
    b. A measure of quality and/or total performance
    c. A way in which problems prohibiting quality or productivity can be found
    d. All of the above

CHAPTER 5
STANDARDS

1. Production Standards have the following parameters:

    a. Short operation times, pinpoint accuracy consistently achievable
    b. Exact method specified
    c. Repetitive operation and exact work content for each operation
    d. All of the above

2. The use of standards will provide:

    a. Uniformity, consistency and accuracy
    b. Improved planning and scheduling
    c. Improved backlog management and work accomplishment
    d. All of the above

3. Maintenance & Repair Standards may be used interchangeably with New Construction Standards:

    a. True
    b. False

4. There should be no more than 4% deviation on EPS jobs over:

    a. 10 hrs.
    b. 25 hrs.
    c. 100 hrs.
    d. 120 hrs.

5. Maintenance and repair standards are for:

    a. Work that takes place in ideal situations
    b. Narrowly defined increments of work
    c. Work requirements that are non-repetitive in nature
    d. A and b above

CHAPTER 6
EPS BACKGROUND

1. Which of the following is not a method of determining EPS standards?

    a. Methods Time Measurement (MTM)
    b. Telephone Surveys of Estimators
    c. Time Study
    d. Work Sampling

2. Which of the following consist of the smallest unit of time?

    a. MTM TMU
    b. EPS element
    c. EPS operation
    d. EPS task

3. Which of the following are not part of the EPS building blocks of time?

    a. General Data
    b. Craft Data
    c. Official Function Time
    d. None of the above

4. Additional Material Handling is considered task time.

    a. True
    b. False

5. Additional Work Locations:

    a. Allow time for craftspersons to move to different locations
    b. Allow travel time for heavy or large equipment to move to different locations
    c. A and b above
    d. None of the above

CHAPTER 7 SECTION 1
EPS APPLICATION

1. Which of the following terms provides time to "remove old and install new" material, parts or equipment.

a. Install
b. Remove
c. Replace
d. Remove & Reinstall

2. The Craft Time Adjustment (CTA) is applied to a task when.

a. There is a hazard involved in a normally non hazardous task
b. The Estimator "feels" that more time will be spent on the task
c. The planned job requires more or less work than the EPS task
d. None of the above

3. Estimators may mix non EPS and EPS tasks in the same phase.

a. True
b. False

4. Additional Material Handling (AMH) is provided:

a. When an armload of material or equipment must be carried from the truck to the work site
b. When two people have to carry a heavy object to the work site from the truck
c. When a craftsperson must move an item to the work area from nearby
d. Both a and b

5. Total Allowed Job Time includes:

a. EPS and Non EPS task time
b. Job Preparation and Craft allowance time
c. Travel Time
d. All of the above.

CHAPTER 7 SECTION 1
EPS APPLICATION

1. Each day the crew is allowed to return to the shop from Travel Zone 5 for lunch.

a. Add 0.55 per man per day of the job to the JP&E Worksheet as a task.
b. Double the Travel Zone number for determining the GDF to be applied.
c. Add 0.1 to the GDF before applying.
d. Add 0.55 hours per man to the JP&E Worksheet as a task.

2. During the landscaping job being performed in Zone 3, a crew of 2 men will have to load the truck and take debris to the dump while the other crew members continue to work at the site. The Planner/Estimator estimates 3 loads on three different days to the dump in Zone 5 in the opposite direction will be required.

a. Add 0.07 per man multiplied by the 3 required trips.
b. Add 0.55 per man multiplied by the 3 required trips.
c. Add 0.55 for Travel Zone 5 plus 0.35 for Travel Zone 3 multiplied by the 3 required trips.
d. Use Travel Zone 5 for determining the GDF.

3. A crew of 4 working in Zone 4 must make a trip to the dump in Zone 5 in the same direction each night before they return to the shop and at the conclusion of the job.

a. Add 0.07 per man per day of the job.
b. Subtract the Zone 5 time from the Zone 4 time and allow the difference per man per day of the job.
c. Use Travel Zone 5 for determining the GDF and add 0.07 per man per day of the job.
d. Use Travel Zone 4 for determining the GDF and add 0.07 per man per day of the job.

4. A crew of 4 working in Zone 4 must make a trip to the dump in Zone 5 in the opposite direction each night before they return to the shop and at the conclusion of the job.

a. Add 0.07 per man per day of the job.
b. Add Zone 4 time to Zone 5 time and multiply per man per day of the job.
c. Add 0.1 to the GDF for Zone 4.
d. Use Travel Zone 5 for determining the GDF.

5. The Roads & Grounds crew is required to haul 105 cubic yards of fill dirt to the land fill in Zone 8 using a dump truck that holds 7 cubic yards per load. The dirt is located in Zone 3 in the same direction as Zone 8.

a. Add the travel time for Zone 8 to the travel time for Zone 3 and multiply that time by the number of required trips per man.
b. Add 0.07 per man per trip multiplied by the number of trips required.
c. Use the GDF for Travel Zone 3 and add a round trip of travel to Zone 8 for each man in the crew for each trip required.
d. Add 0.2 to the GDF.

6. A crew of two has work to perform at various locations in Zones 2 through 7.

a. Determine the Travel Sector for the crew from the first location to the next location in which work is to be performed and subsequently from each work site.
b. Use the GDF for Travel Zone 7 and give each man 0.07 per additional work location.
c. Add a round trip of travel to Zone 5 as a task per man.
d. Add 0.1 per man to the GDF.

7. A crew of 3 must perform work at a remote site 20 minutes beyond Zone 16.

a. Add 0.3 per man to the GDF.
b. Add 20 minutes per man per day of the job as a task to the JP&E Worksheet.
c. Add 0.07 per man per day of the job.
d. None of the above.

Determine the General Data Factor and Allowed Time for each of the following problems.

1. Total Craft Time 45 hours
   Travel Zone 4
   Craft Area Plumbing (Int.)
   Crew Size 3

   GDF _____
   Allowed Time _____

2. Total Craft Time 72 hours
   Travel Zone 8
   Craft Area Moving and Rigging
   Crew Size 4
   Return to shop for lunch

   GDF _____
   Allowed Time _____

3. Total Craft Time 59 hours
   Travel Zone 8
   Craft Area Paint (Gen)
   Crew Size 8

   GDF _____
   Allowed Time _____

4. Total Craft Time 105 hours
   Travel Zone 3
   Craft Area Multi-trade
   Crew Size 7
   Hazardous work situation
   Return to shop for lunch

   GDF _____
   Allowed Time _____

5. Total Craft Time 31 hours
   Travel Zone 5
   Craft Area Paint (Gen)
   Crew Size 4
   Paint Striping Machine used

   GDF _____
   Allowed Time _____

6.	Total Craft Time	93 hours
	Travel Zone	11
	Craft Area	Roads & Grounds (Gen)
	Crew Size	3
	Daily trip to warehouse in Zone 4 in opposite direction at the end of each workday	

GDF _____
Allowed Time _____

7.	Total Craft Time	21 hours
	Travel Zone	Shop
	Craft Area	Masons (Gen)
	Crew Size	1
	Respirator required	

GDF _____
Allowed Time _____

CHAPTER 7 SECTION 2
EPS SINGLE CRAFT JOBS - CARPENTRY TASKS
EXERCISES - PART A

Find the following tasks in the Carpentry Handbook, and complete the following information.

1. Install 60 LF of baseboard & shoe molding.	TTS No. ________ Page No. _______
2. Cut the bottoms of 10 doors so they will close over new carpet installation	TTS No. ________ Page No. _______
3. Eaves, replace 140 LF of fascia strip.	TTS No. ________ Page No. _______
4. Install front & rear storm door closers (hydraulic).	TTS No. ________ Page No. _______
5. Install sheet vinyl in cafeteria, floor is 30' X 55'.	TTS No. ________ Page No. _______
6. Remove door between offices and sheet rock opening.	TTS No. ________ Page No. _______
7. Install sheet rock on new frame wall, wall is 8' high 20' long. install sheet rock on both sides.	TTS No. ________ Page No. _______
8. Install concrete forms stakes & braces for 150 LF new sidewalk.	TTS No. ________ Page No. _______
9. Frame out 3 walls with metal stud system, each wall is 8' X 12'.	TTS No. ________ Page No. _______
10. Install a suspended ceiling of 2'x 4' panels in new conference room, floor dimensions are 20' X 26' (no light fixtures required)	TTS No. ________ Page No. _______

Using the Carpentry Handbook and Job Planning & Estimating Worksheets determine the total labor hour requirement for the following jobs.

CP-01 In Building No. 1355, remove asphalt floor tile and install 12" X 12" vinyl tile in the main hallway on the first floor. Hallway is 9' wide and 130' long, with 3 doors (36" wide) on each side of hall. Floor is concrete. Install new shoe molding on both sides of the hall.

Zone-4 Crew-2

CP-02 In Building No. 255, Rooms 106 and 107, install a suspended grid ceiling using 2' X 4' ceiling tiles. Each room is 14' X 22' . Present ceiling is 10' high, plasterboard 16" oc. New ceiling to be 8' high use a ladder for installation.

Zone-6 Crew-2

CP-03 At Building 1600, remove old asphalt shingles (1 layer) and install new fiberglass shingles with 30 lb. felt. Roof is peak roof each side 75' X 25' (total of 3750 SF). Install new drip flashing around entire perimeter.

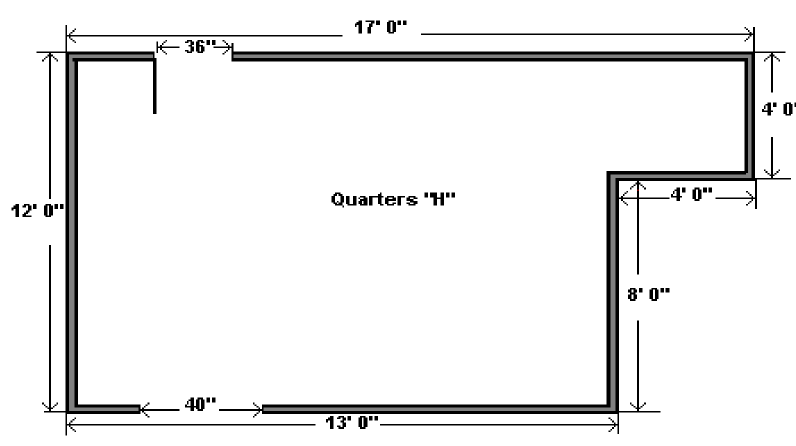
Zone-5 Crew-3

CP-04 In the family housing office Building No. 1763, fabricate and erect a 15' long, 8 ft. high, 16" oc, 2" X 4" wood partition, batt insulated, gypsum wallboard on both sides, with a framed and cased passage door (incl. hardware) in the center of the partition. The crew is allowed to return to the shop for lunch.

Zone-3 Crew-2

CP-05 In Quarters H, 223 Main St. install new sheet vinyl over existing embossed tile floor, lay 1/4" plywood over existing floor before installing new. Floor is 12' X 13' + 4' X 4 ' refrigerator alcove. Install 30 LF new baseboard and shoe molding and 15 LF shoe molding, 1 new 36" door threshold and 1 40" tile to carpet divider strip.

Zone- 4 Crew-2



CHAPTER 7 SECTION 3
EPS SINGLE CRAFT JOBS - ELECTRIC, ELECTRONIC TASKS
EXERCISES - PART A

Find the following tasks in the Electric, Electronic Handbook, and complete the following information.

1. Install 2 hard wired smoke detectors in DVQ.	TTS No. ________ Page No. _______
2. Install a new ceiling fan in the suspended ceiling of the customer service waiting area.	TTS No. ________ Page No. _______
3. Re-lamp 7 - 300 watt bulbs in 30 ' high theater ceiling.	TTS No. ________ Page No. _______
4. Install a new pole mounted single phase 50 KVA transformer using a bucket truck.	TTS No. ________ Page No. _______
5. Install 2 switches and 4 duplex receptacles in new office.	TTS No. ________ Page No. _______
6. Install 250 LF of ENT conduit inside newly framed wood studded walls 16" OC.	TTS No. ________ Page No. _______
7. Install a new 3-phase 225 amp. 20 circuit panel board on wood.	TTS No. ________ Page No. _______
8. Install 250 LF of non-metallic cable and 6 boxes in attic of the new storage area.	TTS No. ________ Page No. _______
9. Install 2 double cross arm poles, each pole having 8 pins and 8 insulators (include excavation & backfill)	TTS No. ________ Page No. _______
10. Replace 10 surface mounted interconnected incandescent fixtures with stem mounted interconnected four tube fluorescent fixtures.	TTS No. ________ Page No. _______

Using the Electric, Electronic Handbook and Job Planning & Estimating Worksheets determine the total labor hour requirement for the following jobs.

EL-01 Replace single anchor guys on two poles at the vehicle storage area, use existing anchors.

Zone-5 Crew-2

EL-02 In Building No. 1528 replace 8 interconnected surface mounted incandescent lights with stem mounted four tube interconnected fluorescent fixtures.

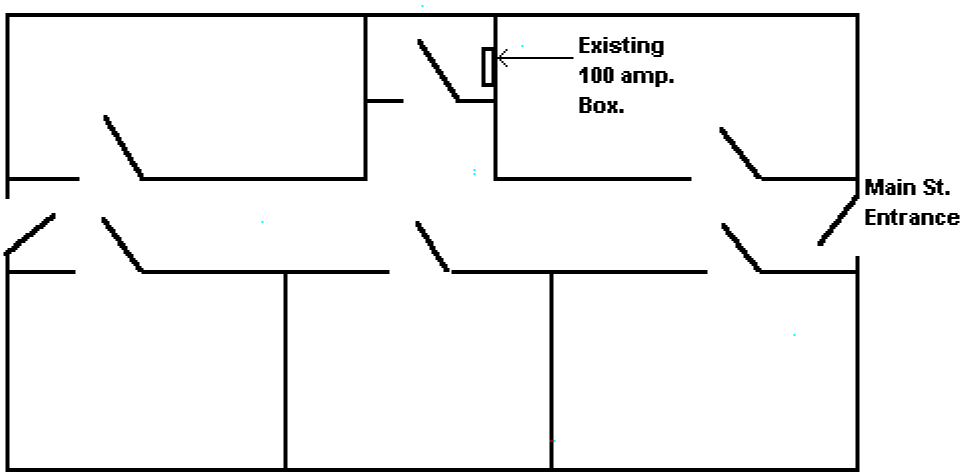
Zone-5 Crew-2

EL-03 Install and connect up a bank of three individually wired, single phase 15 KVA transformers on poles at three locations within the same Zone and Travel Sector. Use a bucket truck. A safety man on the ground is required.

Zone-4 Crew-2

EL-04 In the utility room in Building 342, remove a 16 circuit 100 amp fusible plug, single phase box and upgrade to 225 amp single phase breaker type box. Install on wood. All 16 circuits will be replaced

Zone-6 Crew-2



EL-05 In Building No. 26 remove from concrete 800 LF of 3/4" rigid conduit having 3 #10 AWG conductors. Conduit run includes 15 junction boxes and 5 switch boxes. Average height on wall is 7.5 feet. Due to the building layout, extra time is anticipated for handling materials and equipment.

Zone-3 Crew-2

CHAPTER 7 SECTION 4
EPS SINGLE CRAFT JOBS - HEATING, COOLING, VENTILATING TASKS
EXERCISES - PART A

Find the following tasks in the Heating, Cooling, Ventilating Handbook, and complete the following information.

1. Replace one 30 gal water heater	TTS No. ________ Page No. _______
2. Replace water tower cooling fan and motor.	TTS No. ________ Page No. _______
3. Install a 1.5 ton air conditioner in a raisable sash window.	TTS No. ________ Page No. _______
4. Pump down A/C system to refrigerant recycling unit.	TTS No. ________ Page No. _______
5. Clean, inspect, adjust and lubricate 2 - 50 ton air handling units (Units have cooling coils only).	TTS No. ________ Page No. _______
6. Charge 75 ton A/C system	TTS No. ________ Page No. _______
7. Assist boiler inspector in performing operational test of 6 - 25,000 lb/hr water tube boilers.	TTS No. ________ Page No. _______
8. Clean & inspect in place 12 overhead unit heaters in the sheetmetal shop, use rolling scaffold available in shop.	TTS No. ________ Page No. _______
9. Retrofit 3 airhandler Centrifugal fan shafts by replacing the solid bearings with split type bearings.	TTS No. ________ Page No. _______
10. Clean fire tubes in 6 boilers with pneumatic turbining tool; each boiler has 60 - 12’ tubes	TTS No. ________ Page No. _______

CHAPTER 7 SECTION 4
EPS SINGLE CRAFT JOBS - HEATING, COOLING, VENTILATING TASKS
EXERCISES - PART B

Using the Heating, Cooling, Ventilating Handbook and Job Planning & Estimating Worksheets determine the total labor hour requirement for the following jobs.

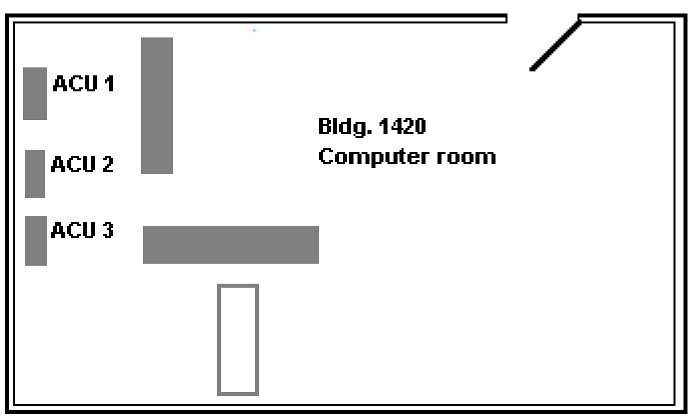
HV-01 In Building No. 693 and 704 machinery rooms replace the dryer in the 50 Ton central A/C system. Buildings 693 and 704 are located in the same travel sector. Recover and recycle CFCs.
Zone-4 Crew-1

HV-02 In Building No. 354, cooling tower #2, replace fan, motor, and float linkage.
Zone-6 Crew-2

HV-03 Clean three water tube boilers, firesides. Each boiler has 180 tubes and is heavily slagged (firebox size is 8' X 13' X 20').
Zone-0 Crew-3

HV-04 Perform semi-annual cleaning and inspection of 40 oil fired floor furnaces in the Merrimac Military Family Housing Apartment complex.
Zone-3 Crew-1

HV-05 In Building 1420, computer room, perform quarterly recurring maintenance on three each, adjoining package units (3 tons each). Maintenance to include lube, oil, filters and operational check.
Zone-5 Crew-1



CHAPTER 7 SECTION 5
EPS SINGLE CRAFT JOBS - JANITORIAL TASKS
EXERCISES - PART A

Find the following tasks in the Janitorial Handbook, and complete the following information.

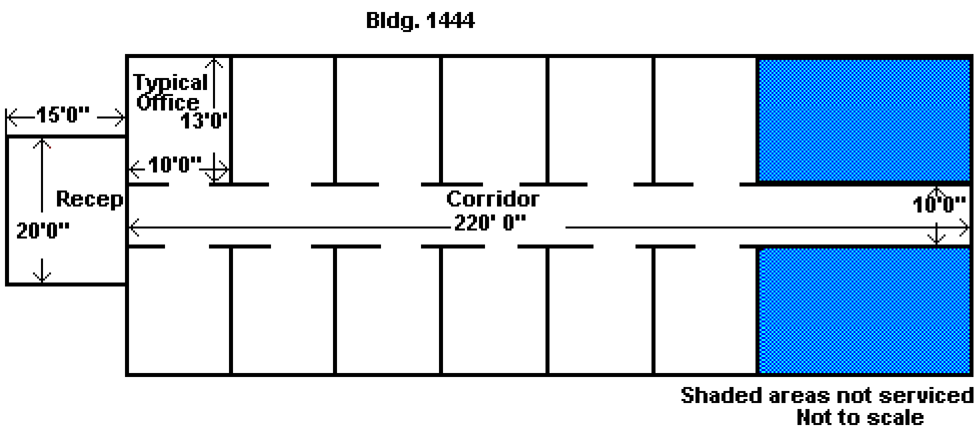
1. Seal concrete floor with non slip sealer, 2500 SF.	TTS No. ________ Page No. _______
2. Strip & rewax floor 1700 SF. No objects to move.	TTS No. ________ Page No. _______
3. Wash & clean 55 ea. 4 ' four tube recessed fluorescent fixtures.	TTS No. ________ Page No. _______
4. Shampoo 3650 SF of office space carpet. Use steam jet.	TTS No. ________ Page No. _______
5. Damp mop computer decking in 25' X 40' computer room.	TTS No. ________ Page No. _______
6. Damp mop lobby & entrance floor, 800 SF, move flag stand, two chairs and sand urn.	TTS No. ________ Page No. _______
7 Clean & service 3 women's rest rooms in Admin. building. Each restroom 150 SF.	TTS No. ________ Page No. _______
8. Vacuum carpet in 15 office spaces, ea. office 124 SF.	TTS No. ________ Page No. _______
9. Spray clean & machine buff 3 corridors ea. 12' wide by 200' long	TTS No. ________ Page No. _______
10. Wash 50 windows on the first floor, ea. window is 4' X 6'. Wash interior & exterior all windows.	TTS No. ________ Page No. _______

Using the Janitorial Handbook and Job Planning & Estimating Worksheets determine the total labor hour requirement for the following jobs.

JT-01 In Building # 276 take down, wash, and reinstall 32 sets of horizontal standard metal slat type venetian blinds. Use a ladder and move furniture as necessary.
Zone-5 Crew-2

JT-02 In Buildings 103, 104, 105, and 108, damp mop, spray clean and machine buff corridors and lobbies. Each building contains 3200 SF of tile floor to be serviced on a weekly basis for the year. All buildings are in the same zone.
Zone-5 Crew-2

JT-03 In Building # 1444, vacuum corridors, offices and reception area two times each week during the entire year. Corridors are 2200 SF, 12 offices each have 130 SF of carpet, and reception area is 300 SF.
Zone-3 Crew-1



JT-04 In the Instructional Building # 1222, clean and service 5 men's and 5 women's washrooms Monday through Friday (except holidays) from 1 October through 30 September. Men's washrooms are 9' X 13', women's washrooms 12' X 15'.
Zone-4 Crew-1

JT-05 Wash windows in Buildings 547, 548, and 549. Each building has 3 floors, 32 windows per floor, wash interior and exterior of first floor windows, wash interior only on 2nd. and 3rd. floor. Windows are 3' X 4.5'. Windows to be washed semi-annually.
Zone-2 Crew-2

CHAPTER 7 SECTION 6
EPS SINGLE CRAFT JOBS - MACHINE SHOP, MACHINE REPAIR TASKS
EXERCISES - PART A

Find the following tasks in the Machine Shop, Machine Repair Handbook, and complete the following information.

1. Make 4 new keys from sample.	TTS No. ________ Page No. _______
2. Disassemble sewage lift pump in shop.	TTS No. ________ Page No. _______
3. Disconnect 15 hp. compressor, prepare for transport to shop.	TTS No. ________ Page No. _______
4. Disassemble for inspection & overhaul the 3 cylinder 15 hp compressor disconnected in problem 3.	TTS No. ________ Page No. _______
5. Disassemble, clean, inspect and reassemble 3 air pressure regulators.	TTS No. ________ Page No. _______
6. Remove old and install new curtain on 18' high roller door	TTS No. ________ Page No. _______
7. Disassemble, clean, lubricate & reassemble 5 ton chain hoist. Replace load chain and sheave, check hoist operation.	TTS No. ________ Page No. _______
8. Fabricate on lathe, two 2" OD X 1.25" ID X 2.5" long bronze bushings, cut oil grooves.	TTS No. ________ Page No. _______
9. Fabricate 5 nuts, 2" standard thread X 1" FROM 3" mild steel hex stock, use power hacksaw and engine lathe.	TTS No. ________ Page No. _______
10. Remove, disassemble, clean, lubricate, reassemble and install the apron on a 24" engine lathe with 7'3" bed.	TTS No. ________ Page No. _______

CHAPTER 7 SECTION 6
EPS SINGLE CRAFT JOBS - MACHINE SHOP, MACHINE REPAIR TASKS
EXERCISES - PART B

Using the Machine Shop, Machine Repair Handbook and Job Planning & Estimating Worksheets determine the total labor hour requirement for the following jobs.

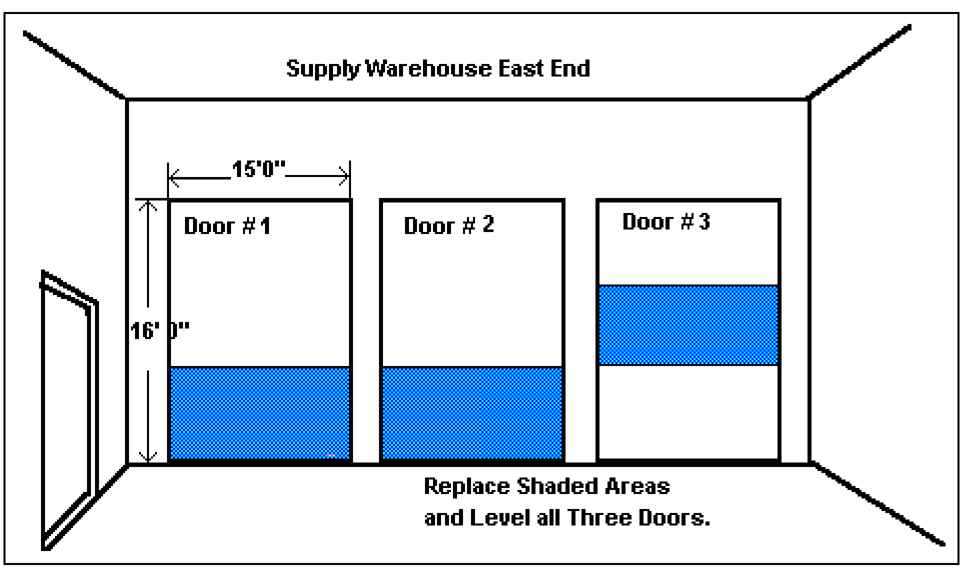
MT-01 At Building # 1365 install new wear rings in the single stage, split casing centrifugal pump.
Zone-7 Crew-1

MT-02 Remove 2 ea. 1/2 hp. sump pumps from 12 manholes located in Travel Zone 3. A safety man is required by OSHA regulations. Transport old pumps to the salvage yard in Zone 5 (same direction from shop).
Zone-3 Crew-2

MT-03 Fabricate 6 ea. 1 1/4" non-sparking brass studs. Cut with power hacksaw and thread both ends on a bolt threading machine. Drill 6 ea. 1-5/32" holes in brass blank flange.
Zone- 0 (Shop) Crew-1

MT-04 At Building # 1338 and 1341 drill and install 6 ea. 2.5' non skid stair treads in each building on the stairs going into the mechanical room.
Zone-4 Crew-1

MT-05 Repair 3 ea. 16' high X 15 ' wide roller doors at supply warehouse loading dock. Doors #1 and #2 require replacing the bottom third sections and door #3 requires replacing the middle third section. Level all three doors.
Zone-5 Crew-2



CHAPTER 7 SECTION 7
EPS SINGLE CRAFT JOBS - MASONRY TASKS
EXERCISES - PART A

Find the following tasks in the Masonry Handbook, and complete the following information.

1. Repoint 65 LF of mortar joints in chimney.	TTS No. ________ Page No. _______
2. Construct an 8" thick brick wall 6' X 30 '.	TTS No. ________ Page No. _______
3. Remove & reinstall boiler firebrick arch, 4' span, single course, 4 rows.	TTS No. ________ Page No. _______
4. Place and float a 6" slab, 10' X 40'.	TTS No. ________ Page No. _______
5. Edge finish slab from problem 4.	TTS No. ________ Page No. _______
6. Assemble & install a metal door frame in an 8" thick brick wall opening.	TTS No. ________ Page No. _______
7. Make 10" X 10" hole in concrete block wall 8" thick. Use hammer & chisel.	TTS No. ________ Page No. _______
8. Repair 28 SF of plaster wall by removing damaged, loose plaster, and patching with one coat application, white finish plaster	TTS No. ________ Page No. _______
9. Where door was removed, block up opening with concrete block, opening is 3 1/2' X 7 1/2'.	TTS No. ________ Page No. _______
10. Replace ceramic wall tile in tub alcove area to be retiled is 4'X 6', 6' X 6', 4' X 6'.	TTS No. ________ Page No. _______

CHAPTER 7 SECTION 7
EPS SINGLE CRAFT JOBS - MASONRY TASKS
EXERCISES - PART B

Using the Masonry Handbook and Job Planning & Estimating Worksheets determine the total labor hour requirement for the following jobs.

MA-01 In Building # 3939, chip out an 11" X 11" hole in the 8" thick concrete wall in room 178 to expand air conditioning supply duct into Room 179. Hole to be 7’ from floor, use drilled 1/2” holes every 1 1/2”.

Zone-3 Crew-1

MA-02 In Building # 342, Room 106, repair a diagonal 1" - 1 1/2" crack in the concrete outer wall. Wall is 8' high and 10' long, crack goes from upper left corner to lower right corner of the wall. Chip out crack with air hammer and fill with mortar. Due to the dust hazard, respirator use is required.

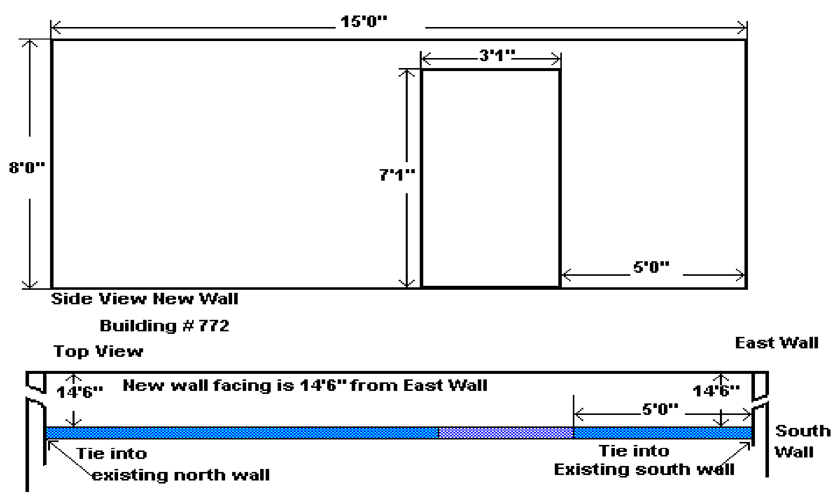
Zone-6 Crew-1

MA-03 Place, wood float once , edge, cut joints and cure 35' X 40', 8" thick concrete slab for machinery pad behind Building # 9825. Use ready mix, poured concrete from ABC Concrete Mix Co. Returns to the shop for lunch are allowed.

Zone-4 Crew-2

MA-04 In Building # 772, construct a concrete block wall 8' high X 15' long. Construct a metal door frame 37" X 85" and install in opening 5' from the start of the wall on the south side of the building. Block is on site.

Zone-5 Crew-2



MA-05 In the heating plant, Building # 256, remove and reinstall the firebrick arch in boiler #2 (7' span 2 courses per row, 2 rows per course), replace 5 SF of firebrick in the walls (9" thick), and replace 4.5 SF of firebrick in the floor of the firebox.

Zone-3 Crew-2

CHAPTER 7 SECTION 8
EPS SINGLE CRAFT JOBS - MOVING, RIGGING TASKS
EXERCISES - PART A

Find the following tasks in the Moving & Rigging Handbook, and complete the following information.

1. Move skid mounted 1000 KV generator unit from storage area to new communication center.	TTS No. ________ Page No. _______
2. Move 8 concrete artillery targets from north to south range area for weekend reserve exercise.	TTS No. ________ Page No. _______
3. Place 15 concrete street barriers to re-route main gate traffic during road repairs.	TTS No. ________ Page No. _______
4. Replace 350' main hoist cable on 25 ton crane.	TTS No. ________ Page No. _______
5. Pour 8 sockets (3/4" wire) for new heavy lift sling.	TTS No. ________ Page No. _______
6. Weight test 2 - 25 ton truck mounted cranes at equip. lot. 5 weights used for 37.5 tons.	TTS No. ________ Page No. _______
7. Erect 5 section high communications tower.	TTS No. ________ Page No. _______
8. Disassemble tower erected in problem 7.	TTS No. ________ Page No. _______
9. Remove old and install new rooftop air handling unit. Machine shop has disconnected old unit.	TTS No. ________ Page No. _______
10. Move 23 desks, 50 4-drawer file cabinets from 3rd floor of Bldg. 2 to the first floor of Bldg. 63. Use crane at Bldg. 2	TTS No. ________ Page No. _______

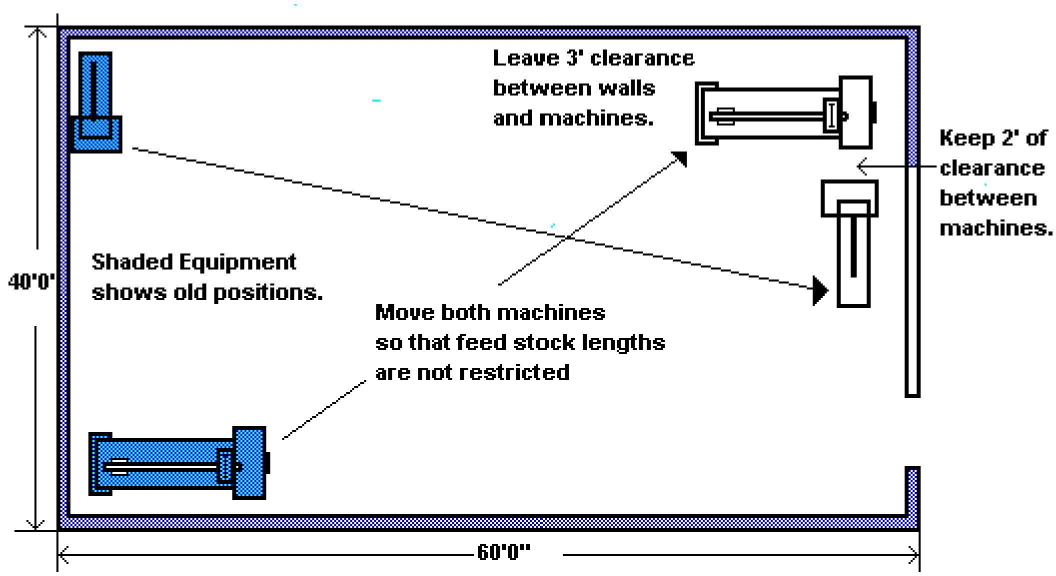
CHAPTER 7 SECTION 8
EPS SINGLE CRAFT JOBS - MOVING & RIGGING TASKS
EXERCISES - PART B

Using the Moving & Rigging Handbook and Job Planning & Estimating Worksheets determine the total labor hour requirement for the following jobs.

MV-01 Replace 250 LF auxiliary hoist cable on truck mounted crane at the HE lot adjacent to the riggers shop. New hoist cable is in the shop.
Zone-1 Crew-2

MV-02 Weight test 4, 20 ton telescopic truck cranes to 150% of rated capacity. Use 3 ea. 10 ton weights for static test. Perform static test only, not side to side.
Zone-1 Crew-2

MV-03 Relocate milling machine and small part turret lathe to new locations within the machine shop. See foreman for placement. Electricians have already disconnected power.
Zone-2 Crew-2



MV-04 Place 2 new 5500 CFM on roof of new community center. Machine shop will assist in setting on foundations.
Zone-5 Crew-2

MV-05 Move 18 metal desks, 15 four drawer file cabinets and 1 safe from property warehouse to Building # 1588 <u>which does not have an elevator</u>. Four desks and 3 file cabinets go to the second floor. Warehouse is in same Travel Zone but in the opposite direction of the shop. A stake body truck will be used to move the items.
Zone-4 Crew-3

CHAPTER 7 SECTION 9
EPS SINGLE CRAFT JOBS - PAINT TASKS
EXERCISES - PART A

Find the following tasks in the Paint Handbook, and complete the following information.

1. Prepare and brush paint 27 hydrants with yellow enamel.	TTS No. ________ Page No. _______
2. Varnish 1 coat, both sides of two doors, each door 3' X 7'.	TTS No. ________ Page No. _______
3. Roller paint 4700 SF of wall surface with flat white water base paint. No cut in required, ceilings 8'.	TTS No. ________ Page No. _______
4. Spray paint 50 class 2 parking stalls with a push type striping machine.	TTS No. ________ Page No. _______
5. Cut in 1300 LF of ceiling and corners with a brush, use white semi-gloss water based paint.	TTS No. ________ Page No. _______
6. Make 35 metal and Scotchlite signs. Each sign is 30" high X 20" wide.	TTS No. ________ Page No. _______
7. Airless spray paint 4700 SF of Sr. officer's quarters wall surface with flat white water based paint. No cut in required, ceilings 8'.	TTS No. ________ Page No. _______
8. Replace 3 broken 20" X 20" window panes with wire inserted glass, cut new glass to fit.	TTS No. ________ Page No. _______
9. Brush paint, 9 double hung, 2 pane over 2 pane windows inside and out with semi gloss white enamel.	TTS No. ________ Page No. _______
10. "Mud & tape" new sheet rock walls in new conference room, room dimensions are 8' X 20' X 14' with one 21 SF door opening.	TTS No. ________ Page No. _______

CHAPTER 7 SECTION 9
EPS SINGLE CRAFT JOBS - PAINT TASKS
EXERCISES - PART B

Using the Paint Handbook and Job Planning & Estimating Worksheets determine the total labor hour requirement for the following jobs.

PT-01 Remove old wall paper in DVQ dining room. Steaming, soaking, and scraping is not required. Install new pre-pasted vinyl (24" wide) wall covering, matching is required. Dining room dimensions are 15' X 22' X 8’ high, with two 7' X 3' door openings and no windows.

Zone-3 Crew-2

PT-02 In Building #432, roller paint two coats of flat light mint green paint on walls and flat white ceiling paint on ceilings of the 6 offices on the first floor. Paint 6" wide baseboard and shoe molding and window trim in semi gloss bottle green. Use all water based latex paints. Each office is 12' X 14' X 8' high, with one 3' X 7' door (Leave stained wood) and one 3' X 4' window.

Zone-4 Crew-2

PT-03 In Building # 9867, 9869 and 9872, water blast and remove soil and lightly flaking paint on block walls. Spray paint block walls with 1 coat of exterior semi gloss beach sand color paint, use airless sprayer. All buildings within walking distance of one another and have approximately 6300 SF of block surface and are one story buildings.

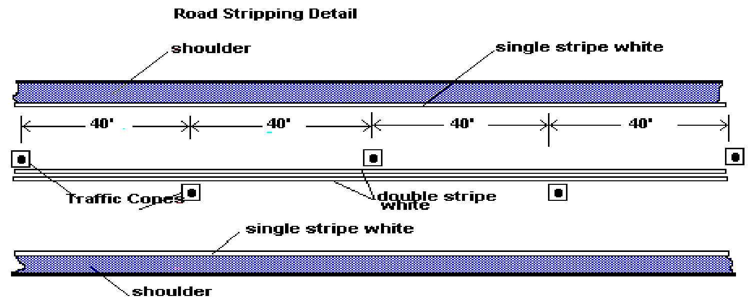
Zone-6 Crew-2

PT-04 In Building #5544, apply tape and three coats of joint compound to ceiling and walls to new training room. Roll paint walls and ceilings with 2 coats of egg shell white flat paint, paint baseboard and door frame trim with 2 coats of semi gloss soft white. Room is 13' X 20 ' X 8' high with one 3' X 7' door opening.

Zone-5 Crew-2

PT-05 Restripe traffic markings (4 lines) on 5 miles of industrial roads with double centerlines and single road edge guide lines. Apply paint with self propelled striping machine. Use traffic cones at a rate of 25 per every 1000 feet (1 cone every 40 feet). Accomplish this job with three passes by using a double sprayhead for the centerlines. The work is located in Zone 4.

Zone-4 Crew-4



CHAPTER 7 SECTION 10
EPS SINGLE CRAFT JOBS - PIPEFITTING, PLUMBING TASKS
EXERCISES - PART A

Find the following tasks in the Pipefitting, Plumbing Handbook, and complete the following information.

1. Repair fire hydrant by replacing the upper barrel cylinder.	TTS No. ________ Page No. _______
2. Install split type rubber insulation on 135 LF of refrigeration lines at bulk frozen storage warehouse	TTS No. ________ Page No. _______
3. Replace 2" ID pressure regulator valve.	TTS No. ________ Page No. _______
4. Replace a 30 gal. gas water heater with a 30 gal. gas water heater.	TTS No. ________ Page No. _______
5. Remove 6 overhead space heaters in Warehouse 1550.	TTS No. ________ Page No. _______
6. Cut ream & thread by machine 16 lengths of 1 1/2" ID pipe, ream & thread both ends of each pipe.	TTS No. ________ Page No. _______
7. Replace 16 lengths of deteriorated pipe with those prepared in problem 6 above.	TTS No. ________ Page No. _______
8. Remove 3 old wall style basins and replace with new basins and hardware.	TTS No. ________ Page No. _______
9. Perform inspection and maintenance to deluge sprinkler system in hospital basement and plant ea. is stand-alone system.	TTS No. ________ Page No. _______
10. Install 75' of 2" ID threaded pipe in a trench.	TTS No. ________ Page No. _______

Using the Pipefitting, Plumbing Handbook and Job Planning & Estimating Worksheets determine the total labor hour requirement for the following jobs.

PP-01 In Building #4006 replace retarding chamber in wet pipe sprinkling system and upon completion perform inspection of entire system (25 heads) and test alarm. Use protective clothing when inspecting 6 heads located in the Biological Research Lab.

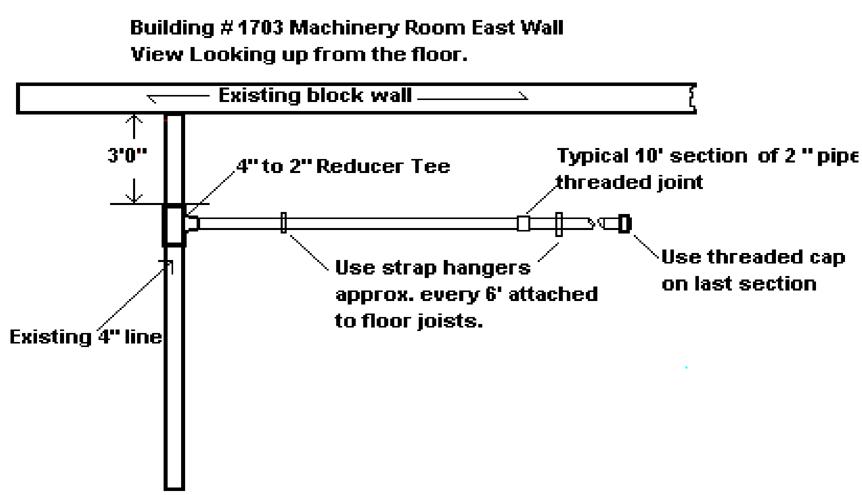
Zone-5 Crew-1

PP-02 Adjacent to Building #1002, replace 208' of damaged 36" ID concrete pipe. Trenching has been done by roads and grounds and pipe to be replaced is already exposed. Roads & grounds will cover new pipe installation, grade and reseed. New pipe is staged at the site. Use a crane already on site.

Zone-6 Crew-3

PP-03 In Building #1703, machinery room cut into existing 4" ID overhead pipe and install a reducing tee and a straight run of 5 (10') sections of 2" ID pipe. Cut/thread pipe & connect with threaded unions. Overhead is 11' floor to ceiling. Do not cap end pipe section (machine to be installed later).

Zone-4 Crew-2



PP-04 Perform semi-annual routine maintenance/minor repair and flush of 6 fire hydrants (cover assys. secured by lock/shield nut) along Constitution Ave. All hydrants are in Zones 3 through 5 in the same Travel Sector.

Zone-4 Crew-2

PP-05 In Barracks Building #3332 disconnect and remove old ice machine and install a new ice machine in same location. Take old ice machine and turn in to disposal yard in Zone 5 in the opposite direction from shop.

Zone-3 Crew-2

CHAPTER 7 SECTION 11
EPS SINGLE CRAFT JOBS - ROADS, GROUNDS, PEST CONTROL TASKS
EXERCISES - PART A

Find the following tasks in the Roads, Grounds, Pest Control Handbook, and complete the following information.

1. Grade 6 miles of dirt range road.	TTS No. ________ Page No. _______
2. Load 20 cu. yds. of fill dirt into dump trucks using front end loader.	TTS No. ________ Page No. _______
3. Patch 32 average size potholes with asphalt using a front end loader to haul material.	TTS No. ________ Page No. _______
4. Mow 3 acres of parade ground using 72" cut riding mower.	TTS No. ________ Page No. _______
5. Provide pest control service for 16000 sq. ft. DEH warehouse.	TTS No. ________ Page No. _______
6. Spread fertilizer at a rate of 40 lbs per 1000 sq. ft. using hand spreader. Area to be fertilized is 2.5 acres.	TTS No. ________ Page No. _______
7. Perform initial inside fence line herbicide treatment for 30,000' of fence line (7 crew day job).	TTS No. ________ Page No. _______
8. Install cyclone fence 8 ft high around new tennis courts, area is 200' X 175'. Install 1 vehicle gate, no barbed wire.	TTS No. ________ Page No. _______
9. Spray for adult mosquitoes using ULV equipped truck at 5 MPH. Treat 8 mile course through housing and troop areas.	TTS No. ________ Page No. ________
10. Breakup and remove old 4" thick concrete driveway. Install new 4" non-reinforced driveway (dimensions are 10' wide X 45 ' long). Use pneumatic hammer for breakup.	TTS No. ________ Page No. _______

Using the Roads, grounds, Pest Control Handbook and Job Planning & Estimating Worksheets, determine the total labor hour requirement for the following jobs.

RD-01 Mow the parade ground, a rectangular, unobstructed area 1000' X 1500', and trim around the edge with a gasoline trimmer. Use a 72" cut riding mower. Perform weekly April through October.

Zone-3 Crew-2

RD-02 Provide pest control services for barracks buildings 1301,1302 & 1304. Perform this service monthly throughout the fiscal year. All barracks located within 200' of each other. Each barracks contains 4500 SF of living space.

Zone-5 Crew-1

RD-03 Treat perimeter of Building #9777 for termites. Drill holes in earth adjacent to slab 4" deep every 20'. Apply 1/2 quart of insecticide per hole using a sub slab injector. Building is 65' X 30'.

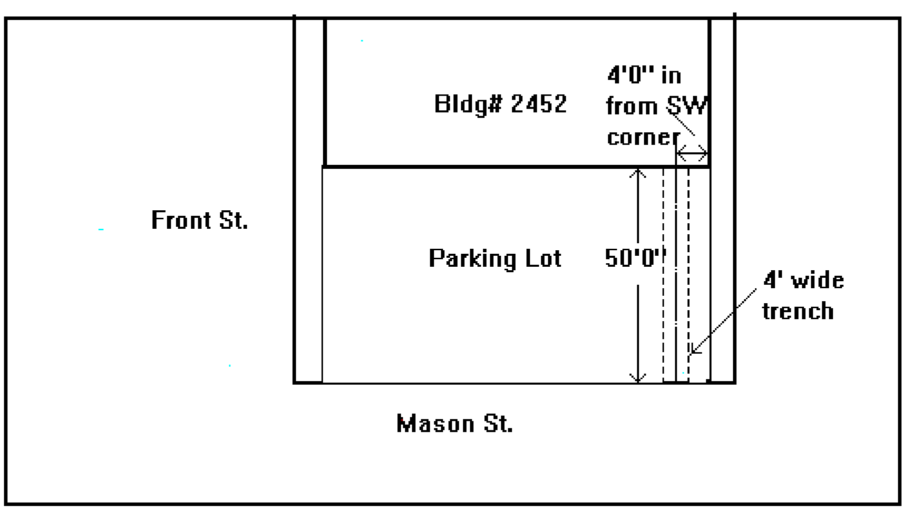
Zone-5 Crew-1

RD-04 Directly behind Building # 2452, backfill a 50' X 4' X 4' trench with a backhoe bucket. Then shovel, rake, and hand tamp base material. Sweep and tack coat, then shovel and hand tamp bituminous pavement (2.5" thick).

Zone-4 Crew-2

RD-05 Directly behind Building #2452, breakup and remove 50' X 4' of 2.5" asphalt parking lot, then excavate a trench in medium packed earth that is 50' long, 4' wide and 4' deep for new drain line. Use backhoe. Place unlighted reflective traffic cones at each end and every 10 feet on both sides of the trench while trench is left open.

Zone-4 Crew-2



CHAPTER 7 SECTION 12
EPS SINGLE CRAFT JOBS - SHEET METAL TASKS
EXERCISES - PART A

Find the following tasks in the Sheet Metal Handbook, and complete the following information.

1. Punch 4 holes in a small sheetmetal part using 15 lb. portable hand punch.	TTS No. ________ Page No. _______
2. Fabricate 40 duct hanger straps from flat bar stock.	TTS No. ________ Page No. _______
3. Install 4 new dock bumpers at the PX warehouse.	TTS No. ________ Page No. _______
4. Install 230 LF of gravel stop (10' sections).	TTS No. ________ Page No. _______
5. Fabricate 4 motor shaft guards ea. 16" Dia X 40" long.	TTS No. ________ Page No. _______
6. Replace 200' of slipjoint gutters & 8 downspouts.	TTS No. ________ Page No. _______
7. Install 6 sections of 10" X 14" HVAV duct.	TTS No. ________ Page No. _______
8. Fabricate 13 - 8 ft sections of 20" X 14 " rectangular 24 gauge duct, using Pittsburgh lock seams.	TTS No. ________ Page No. _______
9. Fabricate 25 rectangular sign blanks 42" X 26" . Drill 5/16 holes in each corner.	TTS No. ________ Page No. _______
10. Shear 2 sheets of heavy plate (ea. 90 lbs) on metal break. Each plate gets 3 shears apiece.	TTS No. ________ Page No. _______

CHAPTER 7 SECTION 12
EPS SINGLE CRAFT JOBS - SHEET METAL TASKS
EXERCISES - PART B

Using the Sheet Metal Handbook and Job Planning & Estimating Worksheets determine the total labor hour requirement for the following jobs.

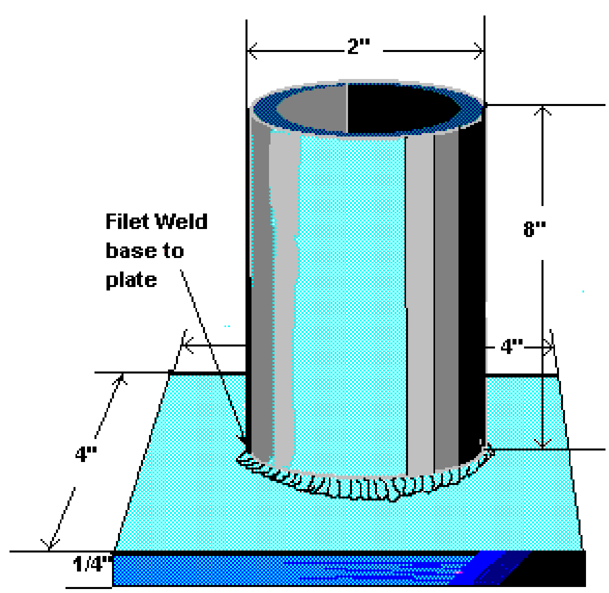
SM-01 Fabricate 4 ea. straight round reducers, 30" dia. to 18" dia. by 48" long. Solder all seams for air tightness.
Zone-Shop Crew-1

SM-02 Fabricate 2 ea. machinery drip pans, 18" X 85" X 3" deep. Double hem edges, rivet and solder corner seams.
Zone-Shop Crew-1

SM-03 Fabricate replacement sheet metal coverings for 60" circumference insulated steam pipe system (100 - 3' long sections), 4 insulated elbow covers, and 1 insulated tee. All fittings are 60 " circumference.
Zone-Shop Crew-2

SM-04 In Building # 5434, install a 30" dia to 18" straight round reducer and 3 ea. 4' long sections of 18" dia. duct to the prepared opening in the wall. Solder all seams.
Zone-5 Crew-2

SM-05 Manually burn (cut) 8 pieces of 1/4" steel plate, each piece 4" X 4", grind all gas cut edges to very smooth finish. Then weld a piece of precut 2" OD, 8" long steel pipe, in center of cut plates. Use one pass when welding. Cut from 4' x 4' piece of sheet steel stored in outside storage facility. Use forklift for handling steel plate.
Zone-Shop Crew-1



CHAPTER 7 SECTION 13
EPS SINGLE CRAFT JOBS - TRACKAGE TASKS
EXERCISES - PART A

Find the following tasks in the Trackage Handbook, and complete the following information.

1. Install a bumping post at end of west yard spur.	TTS No. ________ Page No. _______
2. Remove and reinstall 2 switch frogs.	TTS No. ________ Page No. _______
3. Replace 25 rail anchors including distribution of hardware.	TTS No. ________ Page No. _______
4. Distribute & dispose of 6 rails.	TTS No. ________ Page No. _______
5. Install bolted crossing where track crosses an existing single track.	TTS No. ________ Page No. _______
6. Replace 2 adjoining curved rails using hand tools (rails are welded together). Load & place rail; dispose of old.	TTS No. ________ Page No. _______
7. Raise & surface 175 feet of track with machine tampers, soft subgrade, align the rails and tamp and dress ballast.	TTS No. ________ Page No. _______
8. Replace 4 switch ties, use cable assisted tie puller, pull spikes with hydraulic spike remover, drive new spikes with air hammer. Does not include loading, distributing old/new ties.	TTS No. ________ Page No. _______
9. Replace 15 grade ties using hand tools, remove spikes with hydraulic spike remover, drive spikes with hydraulic hammer, load & distribute new ties, load & unload old ties.	TTS No. ________ Page No. _______
10. Repair one switch, remove & reinstall 1 frog, 2 switch rails, 1 closure rail, use hand tools on bolted rails, load & distribute new rails, dispose of old.	TTS No. ________ Page No. _______

CHAPTER 7 SECTION 13
EPS SINGLE CRAFT JOBS - TRACKAGE TASKS
EXERCISES - PART B

Using the Trackage Handbook and Job Planning & Estimating Worksheets determine the total labor hour requirement for the following jobs.

TK-01 In the tank mount out lot, replace 65 grade ties and 6 switch ties using a "Gandy Snapper". Use tie puller and a hydraulic hammer to drive spikes. Load & distribute the new ties and load and dispose of the old ties. Ties to be replaced are marked with yellow painted stripes.

Zone-6 Crew-6

TK-02 Raise & surface two miles of track (1/2 mile curved and 1 1/2 mile straight). Align the rails and dress ballast using a tamping machine . Subgrade is medium. Track runs from supply warehouse complex to main branchline switch over. (Do not disturb main line track or switch over). Use rail equipment for travel.

Zone 10 Crew-8

TK-03 Refurbish rail yard by replacing 135 grade ties, 22 switch ties (using hydraulic equip.). Raise & resurface 1700 track feet of straight rail through 2 switches and 1300 track feet of curved rail (all yard track bed is medium to firm). Install 2 car bumping posts.(Note: heavy track equipment is prestaged in the yard and stays on site throughout project). Load and place new ties, and dispose of old ties.

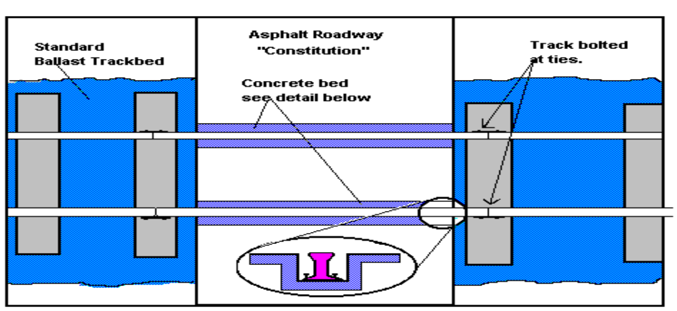
Zone-8 Crew-8

TK-04 At supply storage rail head, repair two switches. Yard entry switch requires new frog and replacement of four switch ties, two switch rails, two closure rails and two straight rails. Siding switch requires replacement of two switch ties, two switch rails, and one closure rail. Rails are bolted. Use hand tools on both switches; use "gandy snapper" and hand tools on the switch ties.

Zone-6 Crew-8

TK-05 At Constitution Road crossing replace the two straight rail sections on the concrete bed single track crossing and the straight connecting rails on both sides of the crossing. Rails are bolted. Using hand tools, resurface the concrete rail bed and reposition studs as required. Remove and reinstall rails manually. Rails prestaged at the crossing.

Zone-8 Crew-10



EPS SINGLE CRAFT JOBS - WHARF BUILDING TASKS
EXERCISES - PART A

Find the following tasks in the Wharf Building Handbook, and complete the following information.

1. Replace two camel floatation cells.	TTS No. ________ Page No. _______
2. Install roofing felt and metal caps on 12 piling tops in the new dolphin at the end of the fuel pier.	TTS No. ________ Page No. _______
3. Remove 1 broken piling broken above the waterline. No cement removal is required. Use floating crane.	TTS No. ________ Page No. _______
4. Repair internal cross beam in two camels.	TTS No. ________ Page No. _______
5. Install 2 wales at east end and 1 at west end of pier. Use mobile crane.	TTS No. ________ Page No. _______
6. Remove 4 pilings broken off below the waterline using a floating crane (bolt but no cement removal required). Piles part of one dolphin assembly.	TTS No. ________ Page No. _______
7. Fabricate & install 6 chock blocks in 3 locations. Use mobile crane; move as required.	TTS No. ________ Page No. _______
8. Remove 3 cemented in fender chock blocks. Using floating crane place removed blocks on work barge. Blocks are 100' apart.	TTS No. ________ Page No. _______
9. Install 6 new piles at 75 foot intervals along quay. Use mobile crane with two hoist pile driver.	TTS No. ________ Page No. _______
10. Open & close 4' X 8' access in wood pier (no asphalt slab) to repair steam line. Timbers are 4" X 12" and are reused.	TTS No. ________ Page No. _______

Using the Wharf Building Handbook and Job Planning & Estimating Worksheets determine the total labor hour requirement for the following jobs.

WH-01 At waterfront, repair one wood camel (camel is out of the water and sitting on its side on the pier). Torch off 12 nuts, replace 6 threaded rods, and replace one complete 20' side fender (support legs OK).

Zone-5 Crew-2

WH-02 Replace 16 wales along the end of the fuel pier using mobile crane. Wales are in pairs (40' between pairs). Remove and install new at each location before removing the next pair. Leave damaged wales on pier to be picked up by Roads and Grounds.

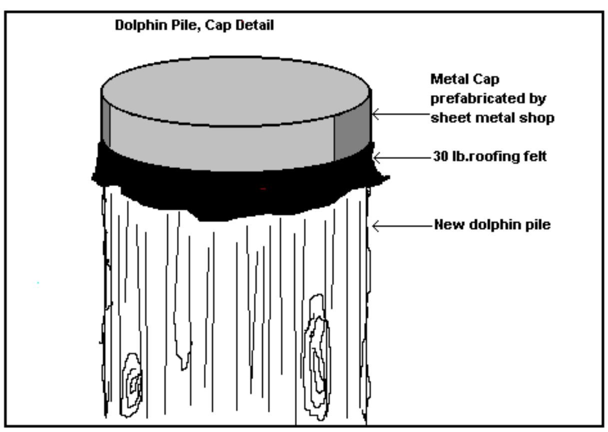
Zone-6 Crew-3

WH-03 Cut out 2 ea. 4'X 8' access holes on Pier 1 and 1 ea. 4' X 4' access hole on Pier 2 so that fitters can replace steam cutout valves and bad sections of steam line under pier. Pier 1 is timber decked; Pier 2 is timber decked with 3" asphalt top.

Zone-6 Crew-3

WH-04 Replace 6 dolphin piles in a cluster of 14 piles. All damaged piles are broken above the waterline and are marked with yellow paint. No cement work is required. Install roofing paper and metal caps on the new piles. Use floating crane staged with new piles and within reach of the dolphin cluster.

Zone-6 Crew-4



WH-05 Replace all 42 broken fender pilings along the container ship quay using a mobile crane. All pilings are broken off above the waterline and are 25' apart along the quay. (Requires bolt removal but no cement work or repairs). Use crane rigged for two hoist pile driver. New pilings are on an open barge at the quay. Place removed piles on same barge. Include 6 min. per move for moving the barge as the job progresses.

Zone-5 Crew-4

MULTI–PHASE / MULTI–CRAFT PROBLEMS

The problems in this section involve more than one craft and must be phased such that the work is performed in a logical manner (i.e. by Job Phase and Craft Phase). Use as many JP&E Worksheets as may be required, with one phase per worksheet. All assumptions and calculations should be shown on the JP&E Worksheet for each phase.

For the Multi–Phase problems, crew sizes are not given in the problem statement. The information below may be used to determine the crew size for a particular type of work within a given craft.

Typical crew sizes (unless otherwise directed or stated in the problem) are as follows:

Craft Skill Required	Typical Crew Size
Shop Work	
All crafts	1
Field Work	
Carpenter (finish)	1
Carpenter (flooring	2
Carpenter (framing)	2
Carpenter (roofing)	4
Electrician (general)	1
Electrician (high voltage)	2
Equipment Operator	1
Laborer (construction)	2
Laborer (grounds)	4
Mason	1
Painter	2
Pest Controller	1
Refuse Collector	2
Sheetmetal Mechanic	2

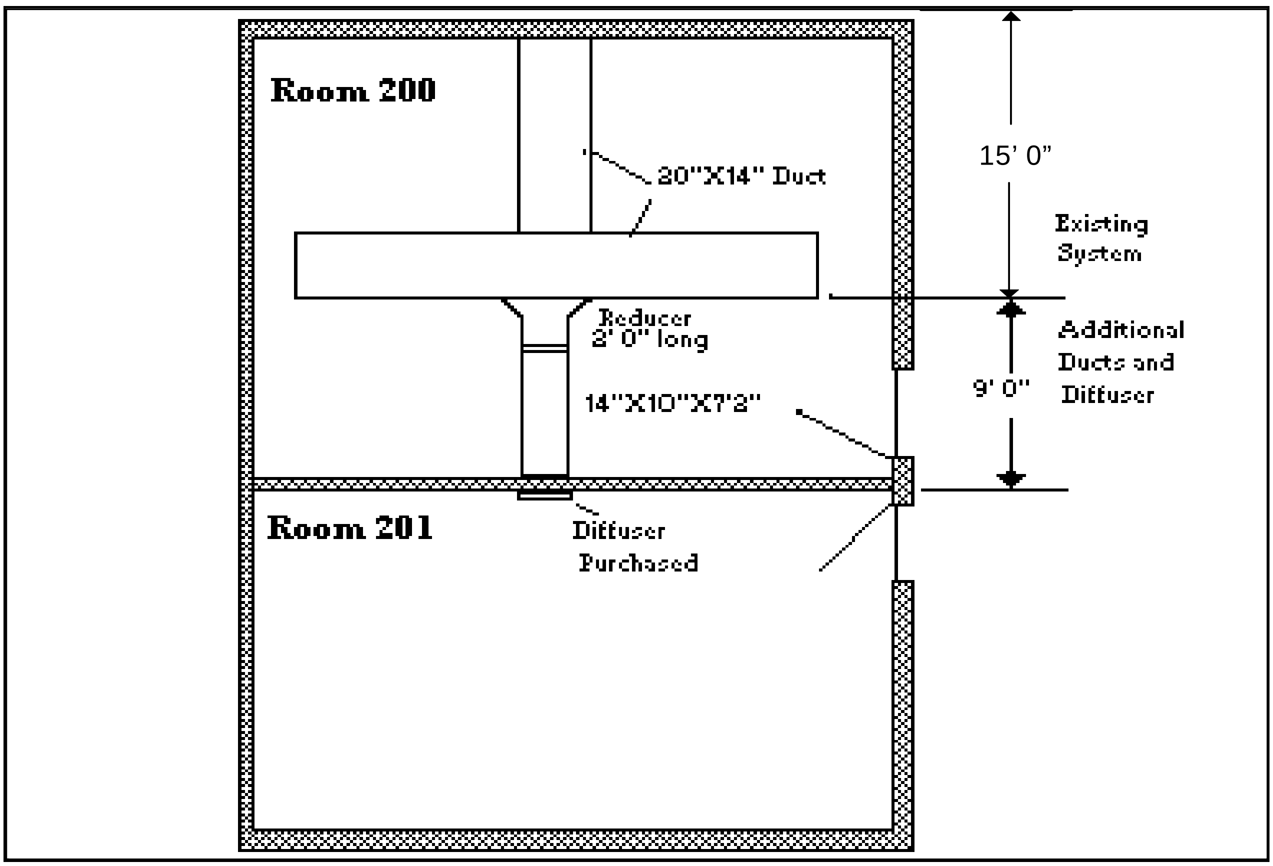
MULTI–PHASE / MULTI–CRAFT PROBLEMS

MP-01 In building # 324, remodel the old storeroom by replacing the deteriorated asphalt tile with new 12” x 12” pebble beige vinyl tile with 15 pound felt underlay, installing baseboard and shoe molding, installing a threshold at the entryway to transition from tile to carpet in outer office, roller painting all walls and ceilings with 2 coats of oyster shell white Latex based flat paint. The room is 20' X 15' with 8' high ceilings and one 3' wide x 7’ high entryway (no door).

Travel Zone = 4

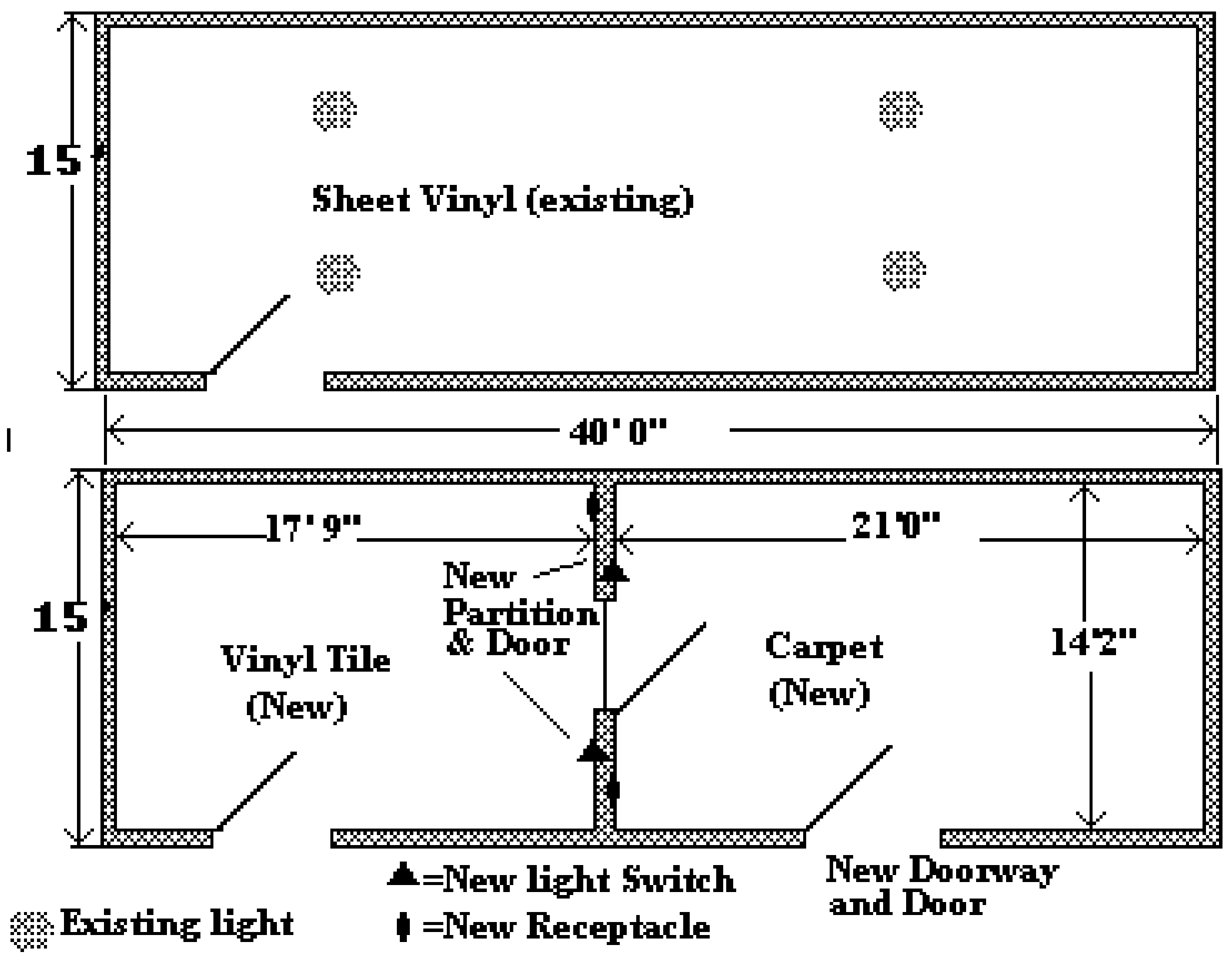
MP-02 In building #16, room 200, tie into and extend the existing duct work to provide ventilation in adjoining room 201. Fabricate reducer and ductwork in shop, manually knock out an opening 8 feet above floor in the 8” thick concrete block connecting wall, install and insulate the new ductwork, install a new purchased rectangular diffuser in room 201, patch and smooth finish the area around the wall opening on both sides. Installation as per the attached drawing.

Travel Zone = 5



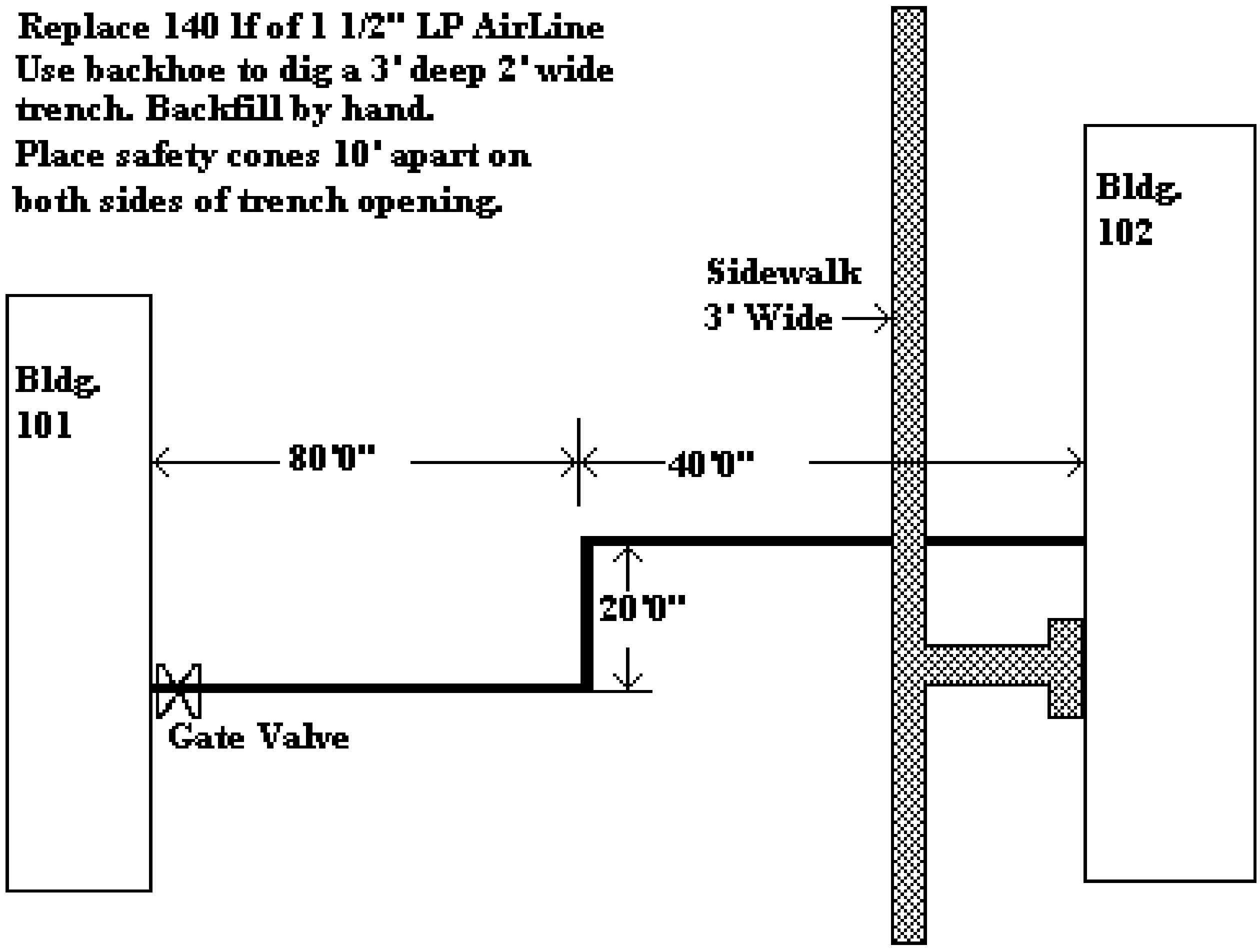
MP-03 In Building # 621, room 180, convert the old conference room into two offices as per the attached sketch. Install a wall partition, one new door in the partition and cut out and install a new access door to the hall, install new switches, electrical outlets and replace the 4 incandescent surface mounted ceiling lights with 4 interconnected stem mounted 4 tube diffuser type fluorescent fixtures. Install new vinyl tile in one office and carpet in the other over the existing sheet vinyl. Install baseboard and shoe molding on both sides of the new partition. Paint walls and ceiling two coats using roller. Trim painting is not required.

Travel Zone = 6



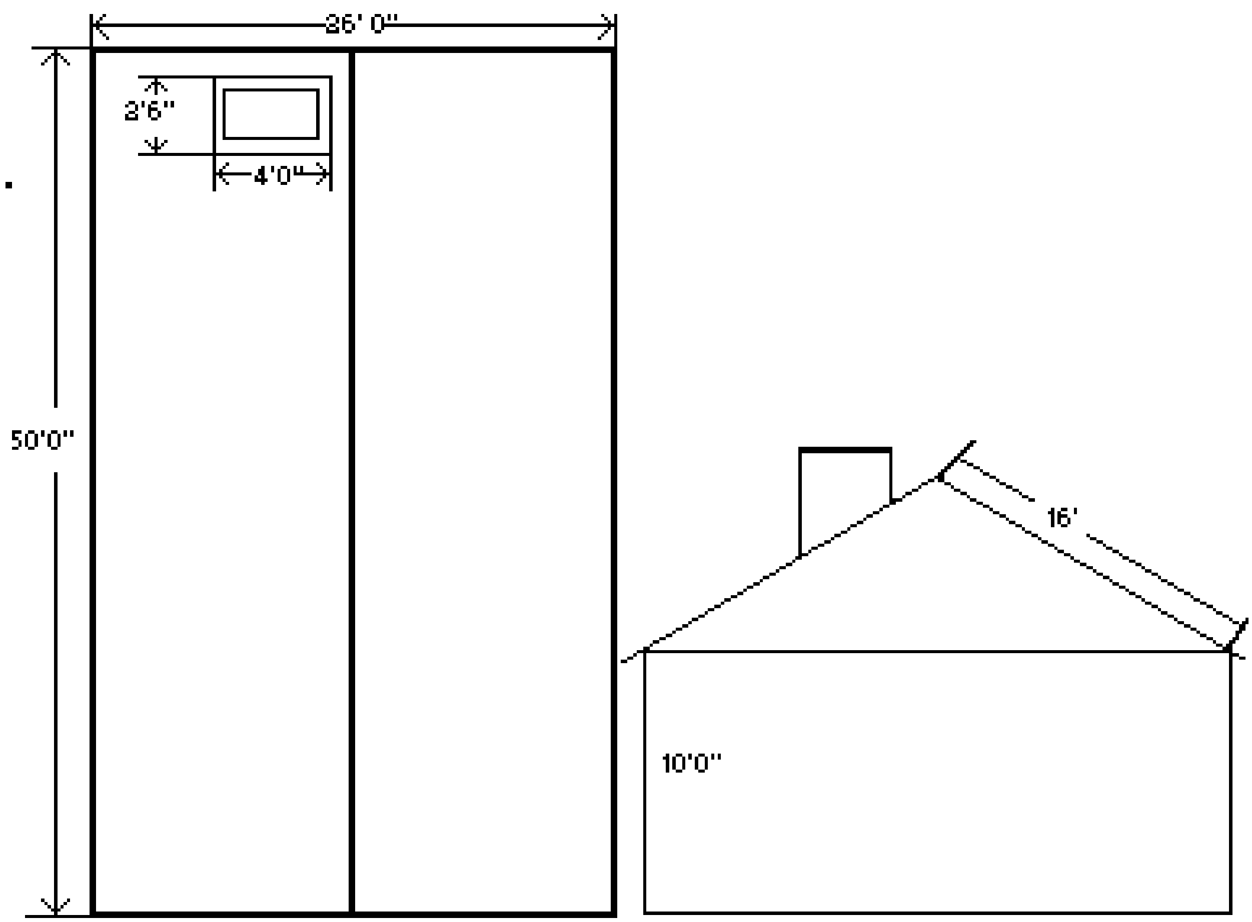
MP-04 Excavate and replace the existing 1 1/2" LP air line between Buildings 101 and 102 as per attached sketch. Replace the in-line gate valve adjacent to Building 101. Use a backhoe to excavate, back fill by hand. Repair the disturbed area, rake, reseed, and hand water. Take old pipe to the salvage yard in Zone 5 in the opposite direction from the job site.

Travel Zone = 4



MP-05 On building # 2044, remove the old asphalt shingle roof down to the sheathing. Replace approx. 180' of deteriorated 1" X 8" sheathing with 3/4" CDX plywood. A truck will be sent for the carpenters to load the roof 3 debris and driver will take debris to landfill. Install new drip flash, new fiberglass three tab shingle roof over 15 lb. felt. Repoint 50 LF of chimney mortar joints (chimney flashing is OK), install aluminum gutters and downspouts front and back. Carpenters erect scaffolding both sides (pipe, 10’ high, 12' long sects.) laborers dismantle scaffold.

Travel Zone = 5, (Landfill = Zone 4 in opposite direction)



MP-06 Building 972 requires the alterations indicated on the attached sketches. As the Planner/Estimator for the job, develop the complete Work Package to include:

- JP&E Worksheets
- Bills of Material
- Job Phase Summary Sheet
- Job Estimate and Cost Summary Sheet

Travel Zone = 7

Related Problem Information:

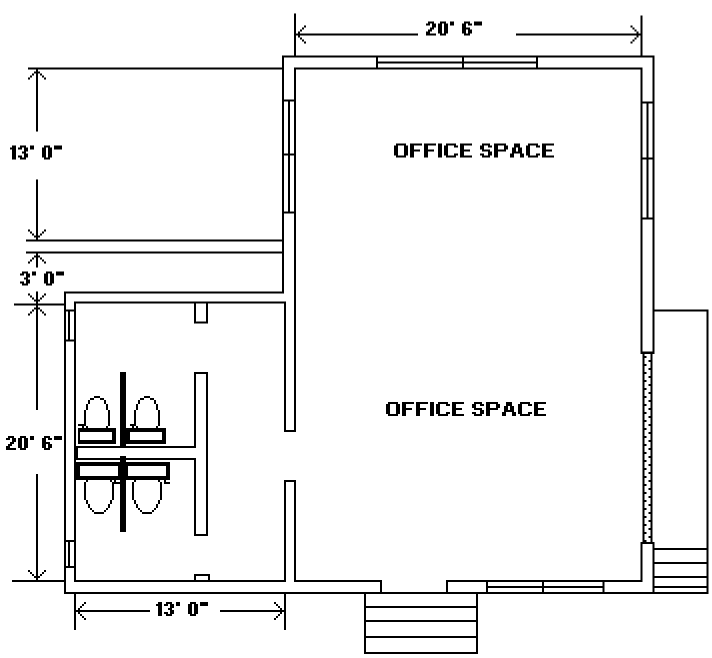
Labor Rates:

Carpenters	$17.90/hour
Electricians	$18.35/hour
Painters	$15.25/hour
Sheetmetal Workers	$17.53/hour
Masons	$16.95/hour
Mechanical Workers	$17.79/hour
Floor Covers	$14.30/hour
Gen Labor	$10.00/hour

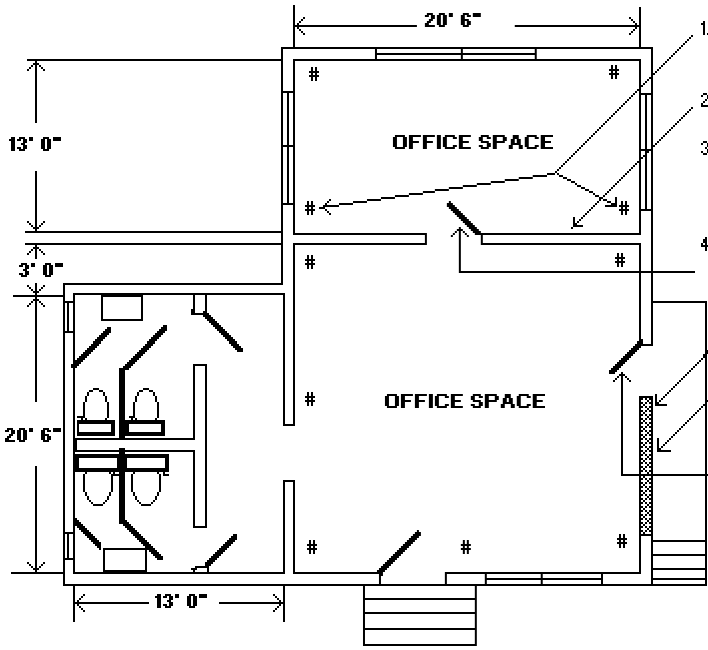
STOCK CATALOGUE ITEMS

DESCRIPTION	COST/UNIT ($)
Framing Lumber 2"x 4"x 10'	3.26 ea.
Furring Strips 1"x 3"x 10'	0.76 ea.
Nails (all)	2.35 lb.
Gypsum board 1/2"x 4' x 10'	9.26 sh.
Paneling Pine 1/4"x 4' x 8'	10.22 sh.
Paneling Walnut 1/4"x 4' x 8'	23.58 sh.
Ceiling Tiles 2' x 4'(ctns of 64)	5.77 ea.
Ceiling Grid 12'	3.85 ea.
Ceiling Grid 2'	0.72 ea.
Wire Ceiling (300 ft rl)	4.33 rl.
Floor Tile Vinyl 12" x 12" (30 pc. ctn)	1.22 ea.
Floor Tile Cement (1 gl. cn.)	14.28 gl.
Prehung Door Metal (9 window)	219.00 ea.
Prehung Hollow Core Door	38.20 ea.
Baseboard	0.48 lf.
Shoe Molding	0.33 lf.
Concrete Block	1.84 ea.
Ceramic Tile 4" x 4"	0.72 ea.

Mortar (80 lb bag)	5.18 bg.
Paint Enamel (1 gl. can)	17.25 gl.
Paint Primer/Sealer	12.93 gl.
Conduit 1/2" (10' lengths)	1.66 pc.
Wire 600V EMT 12/2 (250 rl)	52.71 rl.
Box, Work Electrical (metal single)	1.88 ea.
Duplex Ground Outlet	2.42 ea.
Circuit Breakers (20 amp, single pole)	4.25 ea.
Switches Single Pole	2.49 ea.
Outlet Wall Plate	0.43 ea.
Wire Connectors (med 50 bx)	1.96 bx.
Fluorescent Light Fixture (4'- 4 tube)	141.60 ea.
Fluorescent Tubes 4'	4.60 ea.
Air Conditioner 5000 BTU, Window	295.00 ea.
Lock Set Entrance	19.57 ea.
Lock Set Passage	13.50 ea.
Stain Walnut (qt can)	5.60 qt.
Outlet Switch Plate	0.39 ea.



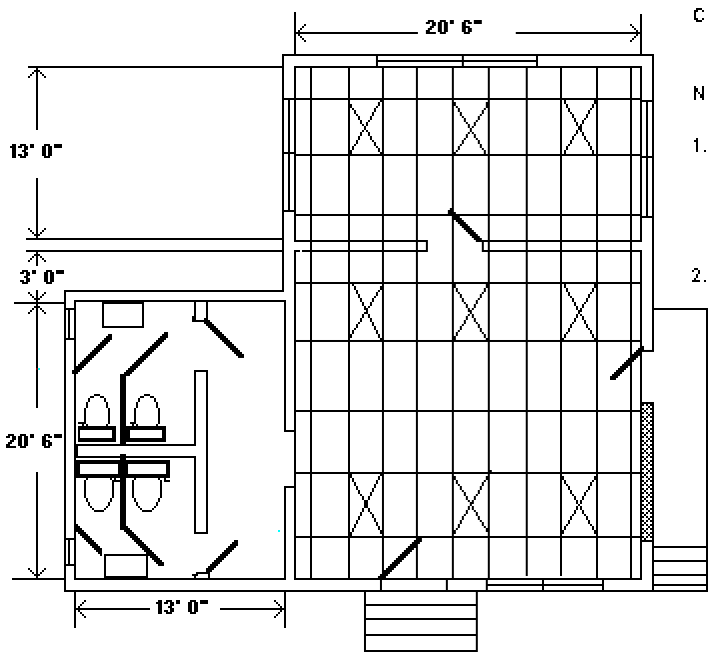
FLOOR PLAN BLDG. 972



1. FUR OUT EXTERIOR WALLS (#) OFFICE SPACES ONLY- USE 2"x 4"- 16" OC.
2. INSTALL PARTITION- USE 2"x4" - 16" OC
3. INSTALL 1/4"x 4' x 8' WALNUT PANELS AND 3" MATCHING BASE- OFFICE SPACES ONLY.
4. PURCHASE AND INSTALL PRE-HUNG FLUSH HOLLOW CORE DOOR IN THE NEW PARTITION.
5. REMOVE 12'x7' OVERHEAD DOOR
6. BLOCK-UP OPENING 8" THICK-LEAVE SPACE FOR 3' x 7' DOOR.
7. PURCHASE AND INSTALL EXTERIOR DOOR (9 WINDOW) 1-3/4" x 3' x 7'.
8. INSTALL 12" x 12" VINYL FLOOR TILE THROUGHOUT INCLUDING THE REST ROOMS- CONCRETE FLOOR IS IN GOOD CONDITION.

FLOOR PLAN BLDG. 972

Sheet 1 of 3

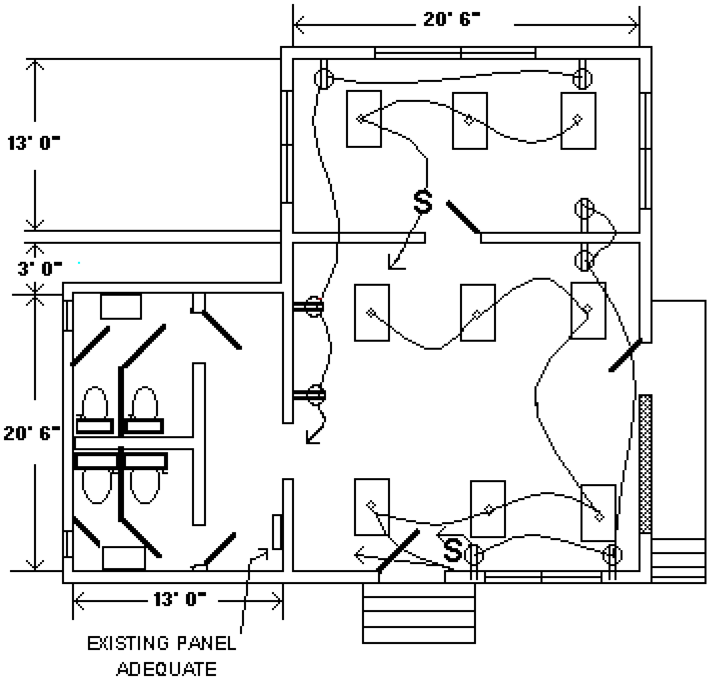


CEILING LAYOUT & PAINT SCHEDULE
BLDG. 972

NOTES:

1. INSTALL SUSPENDED CEILING 8'0" HIGH 24"x 48" PANELS. EXISTING CEILING IS OPEN FRAMING 10' 0" HIGH.
2. PAINT RESTROOMS 1-COAT INTERIOR ENAMEL WALLS AND CEILINGS.
3. PAINT ALL EXISTING WINDOWS AND DOORS. INTERIOR AND EXTERIOR 1- COAT ENAMEL. WINDOWS 3'x5' 6/6 LIGHTS.
4. PAINT 2 NEW DOORS PRIME COAT AND ENAMEL BOTH SIDES.

Sheet 2 of 3



ELECTRICAL LAYOUT
BLDG. 972

NOTES:

1. INSTALL FLUORESCENT LIGHTS 4-TUBE, 4'-DROP-IN TYPE.
2. INSTALL DUPLEX RECEPTACLES AS SHOWN.
3. CIRCUIT BREAKER PANEL HAS ADEQUATE VACANCIES. INSTALL 20 amp BREAKERS.
4. ALL WIRING CONDUIT-600V EMT NO. 12/2 WITH GROUND.

Sheet 3 of 3

RECURRING MAINTENANCE/SERVICES PROBLEMS

RC-01 Provide year round, around the clock boiler tenders in the main boiler plant. One watchstander for console room and one operator as roving operator maintenance.

RC-02 Mow parks and fields (4 parcels), a total of 8 acres. Mow these parcels weekly from 1 April through 30 October. Use a tractor drawn, 128" cut, 5 gang reel mower. The tractor and 5 gang mower are kept in a barn on Parcel #2.

Crew = 1
Travel Zone = 5

RC-03 Provide weekly scheduled pest control services for food service areas as follows:
Bowling Center (2000 sf. and 6 appliances)
Snack Bar (3500 sf. and 6 appliances)
Food Court (5200 sf. and 20 appliances)
Provide weekly fly treatment for food service dumpsters from 1 June through 30 Sep (18 Weeks).
Perform in conjunction with weekly service above.
Bowling Center 1 dumpster
Snack Bar 1 dumpster
Food Court 2 dumpsters

Crew = 1
Travel Zone = 4

RC-04 Provide semi-annual flush and lube of 52 fire hydrants:
36 hydrants on Main Post (Zone #3)
14 Hydrants in Training Area (Zone #5)
2 hydrants at the Reserve Center (Zone #11)

Crew = 1
Travel Zones as described above.

RC-05 Provide twice weekly curbside refuse collection for 800 units of military family housing (400 duplexes). Cans are placed side by side at curb for each duplex, 1 can per unit. Use a rear packer refuse collector (approx. 200 can capacity). Landfill is located in travel zone 4 in the opposite direction from the housing area.

Crew = 2
Travel Zone = 3 for housing; Travel Zone = 4 for land fill.

PREVENTIVE MAINTENANCE PROBLEMS

PM/RM-01 PERFORM QUARTERLY PM/RM TO THE MOTOR CONTROL CENTER AT THE SEWAGE LIFT STATION, LIFT STATION LOCATED IN TRAVEL ZONE 7, PM CREW IS TWO ELECTRICIANS.

FREQUENCY MAINTENANCE CHECKPOINTS REQUIRED

Q	GAIN ACCESS TO LIFT STATION
Q	DRAIN TREATED WATER TANK TO TEST CONTROLS
Q	INSPECT CIRCUIT BREAKER CABINET FOR DISCREPANCIES PER CABINET (2 ea.)
Q	CLEAN CIRCUIT BREAKER CABINET (2 ea.) PER CABINET
Q	INSPECT ELECTRICAL CIRCUITS AND CONNECTIONS PER CABINET (2 EA.)
Q	INSPECT AND CLEAN MOTOR CONTROL CONTACTORS PER BOX (4 Boxes)
Q	INSPECT PRESSURE SWITCH OPERATION PER SWITCH (4 EA.)
Q	CHECK VOLTAGE AT MOTOR PANEL PER PANEL (1 EA.)
Q	CHECK MOTOR WHILE OPERATING FOR EXCESS NOISE OR VIBRATION PER MOTOR (4 Motors)
Q	CHECK OIL LEVEL IN MOTOR AND ADD OIL AS NEEDED
Q	LUBRICATE STATION MOTOR
Q	INSPECT MOTOR CONTROL CENTER LIGHTING
Q	INSPECT CENTER FIRE EXTINGUISHER FOR CONDITION AND DATE OF INSPECTION
Q	CLEAN UP CENTER AFTER MAINTENANCE
Q	FILL OUT MAINTENANCE REPORT

PM/RM - 02 PROVIDE ANNUAL PM/RM FOR 800 GAS WATER HEATERS IN MILITARY FAMILY HOUSING (EACH UNIT HAS ITS OWN WATER HEATER). ALL HOUSING UNITS LOCATED IN TRAVEL ZONE 3, PM CREW IS 1 PLUMBER.

FREQUENCY	MAINTENANCE CHECKPOINTS REQUIRED
A	CHECK FOR WATER LEAKS TO TANK AND PIPING. CHECK FOR FUEL SYSTEM LEAKS
A	CHECK PILOT ON GAS BURNER. ADJUST IF REQUIRED
A	CHECK GAS BURNER FOR PROPER FLAME. ADJUST IF REQUIRED
A	CHECK OPERATION AND CONDITION OF RELIEF VALVE
A	CHECK DRAFT DIVERTER AND CLEAR OPENINGS IF CLOGGED (GAS BURNERS)
A	CHECK FOR PROPER WATER TEMPERATURE SETTING. ADJUST AS REQUIRED
A	CHECK GAS PRESSURE REGULATOR BY USING WATER COLUMN PRESSURE GAGE
A	CHECK CONDITION OF FLUE PIPE, DAMPER AND CHIMNEY
A	CLEAN UP AREA AROUND UNIT
A	FILL OUT MAINTENANCE RECORD/REPORT

PM/RM - 03 PERFORM QUARTERLY, SEMI-ANNUAL AND ANNUAL PM/RM ON FOUR (3) AIR CONDITIONER, PACKAGE UNITS CO-LOCATED IN THE MAIN COMPUTER ROOM OF BUILDING #1226 LOCATED IN TRAVEL ZONE 5. CREW IS 1 HVAC/R MECHANIC.

FREQUENCY	MAINTENANCE CHECKPOINTS REQUIRED
Q	REMOVE ACCESS PANEL HAVING NO BOLTS OR SCREWS
Q	TURN POWER ON AND OFF
Q	CHECK COMPRESSOR OPERATION; CHECK SIGHT GLASS WHILE COMPRESSOR IS RUNNING
SA	CHECK COMPRESSOR OIL LEVEL
Q	REMOVE AND INSTALL CARTRIDGE TYPE FILTER (2 Per unit)
SA	VISUALLY INSPECT COIL
SA	CLEAN COIL, DRIP PAN AND BLOWER
SA	INSPECT ELECTRICAL WIRING AND CONNECTIONS, TIGHTEN CONNECTIONS
Q	INSPECT MOTOR FOR EXCESSIVE HEAT AND NOISE
SA	LUBRICATE SHAFT BEARINGS AND MOTOR
SA	CHECK PIPING AND VALVES FOR REFRIGERANT, WATER AND OIL LEAKS; TIGHTEN CONNECTIONS AS REQUIRED
SA	CHECK BELT FOR WEAR, PROPER TENSION AND ALIGNMENT; ADJUST OR REPLACE AS REQUIRED
A	INSPECT UNIT FOR CORROSION
A	CLEAN, PRIME AND PAINT AREA OF CORROSION (PER SF) ESTIMATE APPROXIMATELY 6 SF PER UNIT
Q	CHECK AND ADJUST AUTOMATIC ON/OFF TIMERS
A	RECHARGE COMPRESSOR (PER 50 LB CYLINDER)
Q	FILL OUT MAINTENANCE RECORD OR REPORT

PM/RM-04 PERFORM MONTHLY AND SEMI ANNUAL PM/RM ON 14 ELECTRICALLY OPERATED, MOTOR DRIVEN, ROLLER CURTAIN DOORS:

PROPERTY WHSE.	2 DOORS 15' HIGH X 10' WIDE
HOSPITAL RECV.	2 DOORS 15' HIGH x 10' WIDE
POST OFFICE	1 DOOR 14' HIGH x 10' WIDE
SUPPLY WHSE.	6 DOORS 20' HIGH 16' WIDE
ORG. VEHICLE MAINT.	3 DOORS, 20' HIGH X 16' WIDE

ALL FACILITIES REQUIRING ROLLER DOOR MAINTENANCE ARE IN TRAVEL ZONE 4, THE MACHINERY REPAIR CREW SIZE IS 2.

FREQUENCY	**MAINTENANCE CHECKPOINT REQUIRED**
M	CHECK WITH DOOR OPERATING PERSONNEL FOR ANY KNOWN DEFICIENCIES
M	OPERATE DOOR
M	CHECK ALIGNMENT OF DOOR, DOOR GUIDES AND LUBRICATE
M	INSPECT GENERAL CONDITION OF DOOR INTERIOR AND EXTERIOR FOR NEED OF PAINT, SIGNS, REPAIRS AND OBSTRUCTIONS
M	REPLACE MISSING/TIGHTEN LOOSE NUTS, BOLTS, ETC.
SA	CHECK ELECTRICAL WIRING AND CONTACTS FOR WEAR
SA	INSPECT AND LUBRICATE MOTOR GEARBOX
M	ADJUST LIMIT SWITCH
SA	INSPECT AND LUBRICATE CHAIN
SA	GREASE DOOR TRACKS
SA	CLEAN UP AROUND DOOR AREA AFTER MAINTENANCE
M	FILL OUT MAINTENANCE RECORD/REPORT

PM/RM-05 PERFORM MONTHLY PM/RM ON THE FOLLOWING FOOD SERVICE EQUIPMENT LOCATED IN THE MAIN GALLEY LOCATED IN TRAVEL ZONE 5. THE CREW SIZE FOR THIS MAINTENANCE IS 1 ELECTRICIAN.

KETTLE, STEAM, FIXED	3 ea.
VEGETABLE PEELER	1 ea.
MIXER, FLOOR	1 ea.
OVEN, CONVECTION	2 ea.
FOOD SLICER	1 ea.
COFFEE MAKER	2 ea.
GRILL	2 ea.
STEAM TABLES	2 ea.
TOASTER, ROTARY	1 ea.
DEEP FAT FRYER	2 ea.

KETTLE, STEAM; FIXED

FREQUENCY	MAINTENANCE CHECKPOINTS REQUIRED
M	CHECK STEAM KETTLE FOR PROPER OPERATION
M	CHECK OPERATION OF PRESSURE REGULATING VALVE PRESSURE GAUGE, SAFETY VALVE, AND DRAIN VALVE. REPLACE HAND WHEELS AND "O" RINGS WHEN REQUIRED
M	INSPECT COVER AND HINGES ON UNITS SO EQUIPPED. LUBRICATE HINGE
M	CHECK PIPING FOR LEAKS AND DAMAGE. TIGHTEN FITTINGS TO STOP STEAM LEAKS IF REQUIRED
M	CHECK AND CLEAN STEAM TRAP AND STRAINER ON DIRECT CONNECTED STEAM UNITS
M	FILL OUT MAINTENANCE RECORD/REPORT

PEELER, VEGETABLE

FREQUENCY	MAINTENANCE CHECKPOINTS REQUIRED
M	CHECK VEGETABLE PEELER FOR PROPER OPERATION. (INCLUDES REMOVING/INSTALLING ACCESS PANEL)
M	CHECK MOTOR AND MOTOR BEARINGS FOR OVERHEATING BY HAND TOUCH
M	CHECK SWITCHES AND CONTROLS FOR DAMAGE AND PROPER OPERATION
M	LUBRICATE VEGETABLE PEELER BY LUBRICATING BUSHINGS AND FILLING GREASE CUP
M	CHECK DOOR FOR LOOSE HINGE AND LATCH FITTINGS. ADJUST IF REQUIRED
M	INSPECT PIPING AND VALVES FOR LEAKS
M	INSPECT ABRASIVE DISK
M	TIGHTEN OR REPLACE LOOSE, MISSING, OR DAMAGED NUTS, BOLTS, OR SCREWS
M	CHECK BELT FOR PROPER TENSION AND ALIGNMENT, ADJUST OR REPLACE AS REQUIRED
M	FILL OUT MAINTENANCE RECORD/REPORT

MIXER, FLOOR

FREQUENCY	MAINTENANCE CHECKPOINTS REQUIRED
M	CHECK WITH OPERATING PERSONNEL FOR ANY KNOWN DEFICIENCIES
M	TURN MIXER ON, ALLOW TO RUN AND VARY SPEED TO CHECK OPERATION
M	CHECK MIXER FOR ALIGNMENT AND VIBRATION, ALIGN IF NECESSARY
M	CHECK OIL LEVEL IN TRANSMISSION, ADD AS REQUIRED
M	CHECK BELT, ADJUST TENSION AND/OR PULLEY AS REQUIRED
M	CHECK MIXER MOTOR, SWITCHES, AND CONTROLS, CHECK MOTOR AND BEARING FOR OVERHEATING

M	INSPECT PIPING AND VALVES FOR LEAKS, IF UNIT IS EQUIPPED WITH WATER TANK
M	INSURE ANCHOR BOLTS ARE TIGHT
M	TIGHTEN OR REPLACE LOOSE, MISSING OR DAMAGED NUTS, BOLTS OR SCREWS
M	FILL OUT MAINTENANCE RECORD/REPORT

OVEN, CONVECTION

FREQUENCY	MAINTENANCE CHECKPOINTS REQUIRED
M	CHECK DOORS FOR WARPING AND ALIGNMENT
M	TIGHTEN AND REPLACE ANY LOOSE NUTS, BOLTS, OR SCREWS
M	CHECK ELEMENT, SWITCHES, CONTROLS AND WIRING ON ELECTRICALLY HEATED UNITS FOR DEFECTS
M	REMOVE ACCESS PANEL, CHECK FAN BLADES AND FAN MOTOR
M	CHECK SEALS AROUND DOORS, LUBRICATE HINGES (3)
M	CHECK CALIBRATION OF THERMOSTAT
M	FILL OUT MAINTENANCE RECORD/REPORT

FOOD SLICER

FREQUENCY	MAINTENANCE CHECKPOINTS REQUIRED
M	TIGHTEN OR REPLACE LOOSE, MISSING OR DAMAGED NUTS, BOLTS, OR SCREWS
M	LUBRICATE FOOD SLICER AS REQUIRED. USE MINERAL OIL ON PARTS THAT COME IN CONTACT WITH FOOD
M	CHECK CONDITION OF BLADE, BLADE GUARD, GUIDES, AND CONTROLS
M	CHECK MOTOR AND MOTOR BEARINGS FOR OVERHEATING BY HAND TOUCH
M	ADJUST BLADE, MOTOR OR CARRIAGE
M	CHECK LUBRICANT IN GEAR CASE, ADD AS REQUIRED

M	FILL OUT MAINTENANCE RECORD/REPORT

COFFEE MAKER/URN

FREQUENCY	MAINTENANCE CHECKPOINTS REQUIRED
M	CHECK THERMOSTAT AND TEMPERATURE GAUGE ON COFFEE URN/MAKER. CALIBRATE IF NECESSARY
M	CHECK ELECTRICAL CONNECTIONS AND WIRING FOR DEFECTS. TIGHTEN LOOSE CONNECTIONS
M	EXAMINE EQUIPMENT, VALVES, AND PIPING FOR LEAKS
M	INSPECT URN/COFFEE MAKER FOR LEAKS AT WATER GAUGES GLASSES AND AT VALVES. REPACK VALVES IF NECESSARY
M	TIGHTEN OR REPLACE LOOSE, MISSING OR DAMAGED NUTS, BOLTS OR SCREWS
M	CHECK OPERATION OF LIGHTS
M	CHECK OPERATION OF ON/OFF SWITCH
M	FILL OUT MAINTENANCE RECORD/REPORT

GRILL

FREQUENCY	MAINTENANCE CHECKPOINTS REQUIRED
M	TIGHTEN OR REPLACE ANY LOOSE NUTS, BOLTS, SCREWS. REPLACE BROKEN KNOBS.
M	CHECK CONNECTIONS AND WIRING ON ELECTRICALLY OPERATED UNITS. TIGHTEN CONNECTIONS
M	TURN MAIN POWER SUPPLY ON/OFF
M	CHECK POWER PLUG FOR LOOSE WIRES, TIGHTEN AS REQUIRED
M	CHECK CALIBRATION OF THERMOSTATS
M	FILL OUT MAINTENANCE RECORD/REPORT

STEAM TABLE

FREQUENCY	MAINTENANCE CHECKPOINTS REQUIRED
M	INSPECT WATER COMPARTMENT, STEAM COIL, VALVES AND PIPING FOR LEAKS

M	CHECK INSULATORS, CONNECTIONS, AND WIRING ON ELECTRICALLY OPERATED UNITS. TIGHTEN LOOSE CONNECTIONS
M	CHECK CONDITION OF COVERS AND RECEPTACLES
M	CHECK THERMOSTAT AND TEMPERATURE GAUGE, CALIBRATE THERMOSTAT IF NECESSARY
M	FILL OUT MAINTENANCE RECORD/REPORT

TOASTER, ROTARY

FREQUENCY	MAINTENANCE CHECKPOINTS REQUIRED
M	TEST OPERATION OF TOASTER BY TOASTING SAMPLE SLICE OF BREAD
M	CHECK HEATING ELEMENTS ON ELECTRICALLY OPERATED UNITS
M	CHECK ELECTRIC INSULATORS, CONNECTIONS, AND WIRING (INCLUDES REMOVING ACCESS PANEL)
M	INSPECT ALIGNMENT OF BASKETS AND CONVEYOR CHAINS. ALIGN IF NECESSARY
M	LUBRICATE CHAIN
M	CHECK MOTOR AND MOTOR BEARINGS FOR OVERHEATING BY HAND TOUCH
M	TIGHTEN OR REPLACE LOOSE, MISSING, OR DAMAGED NUTS, BOLTS, OR SCREWS
M	LUBRICATE MOTOR (2 OIL HOLES)
M	FILL OUT MAINTENANCE RECORD/REPORT

DEEP FAT FRYER, CONVENTIONAL TYPE

FREQUENCY	MAINTENANCE CHECKPOINTS REQUIRED
M	EXAMINE COMPARTMENTS, VALVES, AND PIPING FOR LEAKS
M	CHECK THERMOSTAT WITH THERMOMETER. CALIBRATE IF NECESSARY
M	CHECK ELEMENTS, SWITCHES, CONTROLS, CONTACTS, AND WIRING ON ELECTRICALLY HEATED UNITS FOR DEFECTS

M CHECK BASKET OR RACK FOR BENDS OR DEFECTS
STRAIGHTEN BENDS WHEN NECESSARY

M TIGHTEN OR REPLACE LOOSE, MISSING OR DAMAGED NUTS,
BOLTS, OR SCREWS

M FILL OUT MAINTENANCE RECORD/REPORT

STANDARD NUMBER - 70150- PG. 355

MOTOR CONTROL CENTER - SEWAGE LIFT STATION

CHECKPNT	CHECKPOINT DESCRIPTION	HRS	OCC	TOT HRS
70151	GAIN ACCESS TO LIFT STATION	0.011	___	_______
70152	DRAIN TREATED WATER TANK TO TEST CONTROLS	0.503	___	_______
70153	INSPECT CIRCUIT BREAKER CABINET FOR DISCREPANCIES PER CABINET (2 ea.)	0.072	___	_______
70154	CLEAN CIRCUIT BREAKER CABINET (2 ea.) PER CABINET	0.002	___	_______
70155	CHECK CABINET FOR LOOSE AND MISSING HARDWARE REPAIR AS NEEDED PER CABINET	0.004	___	_______
70156	INSPECT ELECTRICAL CIRCUITS AND CONNECTIONS (2 ea.) PER CABINET	0.092	___	_______
70157	INSPECT AND CLEAN MOTOR CONTROL CONTACTORS (4 boxes) PER BOX	0.138	___	_______
70158	INSPECT PRESSURE SWITCH OPERATION(4 ea.) PER SWITCH	0.101	___	_______
70159	CHECK VOLTAGE AT MOTOR PANEL (1 ea.) PER PANEL	0.079	___	_______
70160	CHECK MOTOR WHILE OPERATING FOR EXCESS NOISE OR VIBRATION (4 Motors) PER MOTOR	0.017	___	_______
70161	CHECK OIL LEVEL IN MOTOR AND ADD OIL AS NEEDED PER MOTOR	0.007	___	_______
70162	LUBRICATE STATION MOTOR, PER MOTOR	0.036	___	_______
70163	GET, USE AND ASIDE EXTENSION LADDER AS NEEDED	0.135	___	_______
70164	INSPECT MOTOR CONTROL CENTER LIGHTING	0.014	___	_______
70165	INSPECT CENTER FIRE EXTINGUISHER FOR CONDITION AND DATE OF INSPECTION	0.097	___	_______
70166	CLEAN UP CENTER AFTER MAINTENANCE	0.051	___	_______
70167	FILL OUT MAINTENANCE REPORT	0.017	___	_______
	TOTAL EPS HOURS	_______	___	_______

WATER HEATER - GAS OR OIL FIRED

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
45301	CHECK FOR WATER LEAKS TO TANK AND PIPING CHECK FOR FUEL SYSTEM LEAKS	0.059	___	_______
45302	ADJUST PILOT FIRE ON OIL BURNER	0.209	___	_______
45303	CHECK PILOT ON OIL BURNER. ADJUST IF REQUIRED	0.056	___	_______
45304	CHECK PILOT ON GAS BURNER. ADJUST IF REQUIRED	0.010	___	_______
45305	CHECK GAS BURNER FOR PROPER FLAME. ADJUST IF REQUIRED	.081	___	_______
45306	ADJUST OIL BURNER FLAME	0.206	___	_______
45307	CHECK OIL BURNER FLAME. ADJUST IF REQUIRED	0.122	___	_______
45308	CHECK OPERATION AND CONDITION OF RELIEF VALVE	0.008	___	_______
45309	CHECK AUTOMATIC CONTROLS FOR PROPER OPERATION (TEMPERATURE REGULATORS, THERMOSTATIC DEVICES, AUTOMATIC FUEL SHUT OFF VALVE, ETC.)	0.072	___	_______
45310	CHECK DRAFT DIVERTER AND CLEAR OPENINGS IF CLOGGED (GAS BURNERS)	0.021	___	_______
45311	CHECK FUEL STRAINER ELEMENT ON OIL BURNER	0.052	___	_______
45312	CHECK FUEL LEVEL IN TANK. CHECK TANK, FILL PIPE AND FUEL LINES AND CONNECTIONS FOR DAMAGE	0.017	___	_______
45313	INSPECT, CLEAN, AND ADJUST ELECTRODES AND NOZZLES ON OIL BURNERS. INSPECT FIRE BOX AND FLAME DETECTION SCANNER	0.195	___	_______
45314	CHECK ELECTRICAL WIRING FOR FRAYING AND LOOSE CONNECTIONS ON OIL BURNER	0.055	___	_______
45315	CHECK FOR PROPER WATER TEMPERATURE SETTING. ADJUST AS REQUIRED	0.002	___	_______
45316	CLEAN FIRE BOX	0.444	___	_______

45317	CHECK FOR PROPER DRAFT ADJUSTMENT. ADJUST DRAFT METER IF NECESSARY (OIL BURNERS)	0.004	___	_______
45318	CHECK GAS PRESSURE REGULATOR BY USING WATER COLUMN PRESSURE GAGE	0.067	___	_______
45319	CHECK CONDITION OF FLUE PIPE, DAMPER AND CHIMNEY	0.113	___	_______
45320	DRAIN AND FLUSH TANK (AVERAGE 75 GAL)	1.013	___	_______
45321	CLEAN UP AREA AROUND UNIT	0.051	___	_______
45322	FILL OUT MAINTENANCE RECORD/REPORT	0.017	___	_______
_______	_______________________________	_______	___	_______
_______	_______________________________	_______	___	_______
_______	_______________________________	_______	___	_______
_______	_______________________________	_______	___	_______
_______	_______________________________	_______	___	_______
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_______	_______________________________	_______	___	_______
_______	_______________________________	_______	___	_______
_______	_______________________________	_______	___	_______
_______	_______________________________	_______	___	_______
_______	_______________________________	_______	___	_______
_______	_______________________________	_______	___	_______
	TOTAL EPS HOURS	_______	___	_______

AIR CONDITIONER, PACKAGE UNIT

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
10751	REMOVE ACCESS PANEL HAVING NO BOLTS OR SCREWS	0.027	___	_______
10752	REMOVE AND INSTALL ACCESS PANEL, BOLTED OR SCREWED ON (PER PANEL)	0.102	___	_______
10753	TURN POWER ON AND OFF	0.006	___	_______
10754	CHECK COMPRESSOR OPERATION; CHECK SIGHT GLASS WHILE COMPRESSOR IS RUNNING	0.025	___	_______
10755	CHECK COMPRESSOR OIL LEVEL	0.004	___	_______
10756	REMOVE AND INSTALL CARTRIDGE TYPE FILTER	0.007	___	_______
10757	VISUALLY INSPECT COIL	0.021	___	_______
10758	CLEAN COIL, DRIP PAN AND BLOWER	0.296	___	_______
10759	INSPECT ELECTRICAL WIRING AND CONNECTIONS, TIGHTEN CONNECTIONS	0.092	___	_______
10760	INSPECT MOTOR FOR EXCESSIVE HEAT AND NOISE	0.017	___	_______
10761	LUBRICATE SHAFT BEARINGS AND MOTOR	0.036	___	_______
10762	CHECK PIPING AND VALVES FOR REFRIGERANT, WATER AND OIL LEAKS; TIGHTEN CONNECTIONS AS REQUIRED	0.059	___	_______
10763	CHECK BELT FOR WEAR, PROPER TENSION AND ALIGNMENT; ADJUST OR REPLACE AS REQUIRED	0.022	___	_______
10764	INSPECT UNIT FOR CORROSION	0.021	___	_______
10765	CLEAN, PRIME AND PAINT AREA OF CORROSION (PER SF)	0.041	___	_______
10766	CHECK AND ADJUST AUTOMATIC ON/OFF TIMERS	0.014	___	_______
10767	RECHARGE COMPRESSOR (PER 50 LB CYLINDER)	1.344	___	_______
10768	CLEAN UP AREA AROUND UNIT (PER 100 SF)	0.051	___	_______
10769	FILL OUT MAINTENANCE RECORD OR REPORT	0.017	___	_______
	TOTAL EPS HOURS	_______	___	______

DOOR, OVERHEAD ROLLER CURTAIN, MOTOR DRIVEN, UP TO 16' H. X 15' W.

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
30201	FILL OUT TRIP TICKET (OFF BASE PASS) PER DAY	0.024	___	_______
30202	CHECK WITH DOOR OPERATING PERSONNEL FOR ANY KNOWN DEFICIENCIES	0.027	___	_______
30203	OPERATE DOOR	0.104	___	_______
30204	CHECK ALIGNMENT OF DOOR, DOOR GUIDES AND LUBRICATE	0.677	___	_______
30205	INSPECT GENERAL CONDITION OF DOOR INTERIOR AND EXTERIOR FOR NEED OF PAINT, SIGNS, REPAIRS AND OBSTRUCTIONS	0.017	___	_______
30206	REPLACE MISSING/TIGHTEN LOOSE NUTS, BOLTS, ETC.	0.045	___	_______
30207	CHECK ELECTRICAL WIRING AND CONTACTS FOR WEAR	0.364	___	_______
30208	INSPECT AND LUBRICATE MOTOR GEARBOX	0.154	___	_______
30209	ADJUST LIMIT SWITCH	0.172	___	_______
30210	INSPECT AND LUBRICATE CHAIN	0.048	___	_______
30211	GREASE DOOR TRACKS	0.230	___	_______
30212	CLEAN UP AROUND DOOR AREA AFTER MAINTENANCE	0.051	___	_______
30213	FILL OUT MAINTENANCE RECORD/REPORT	0.017	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
	TOTAL EPS HOURS	______	___	_______

DOOR, OVERHEAD ROLLER CURTAIN, MOTOR DRIVEN, 16'1"-24'H X 15' 1"-25'W. WIDE

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
30226	FILL OUT TRIP TICKET (OFF BASE PASS) PER DAY	0.024	___	_______
30227	CHECK WITH DOOR OPERATING PERSONNEL FOR ANY KNOWN DEFICIENCIES	0.027	___	_______
30228	OPERATE DOOR	0.104	___	_______
30229	CHECK ALIGNMENT OF DOOR, DOOR GUIDES AND LUBRICATE	0.677	___	_______
30230	INSPECT GENERAL CONDITION OF DOOR INTERIOR AND EXTERIOR FOR NEED OF PAINT, SIGNS, REPAIRS AND OBSTRUCTIONS	0.041	___	_______
30231	REPLACE MISSING/TIGHTEN LOOSE NUTS, BOLTS, ETC.	0.045	___	_______
30232	CHECK ELECTRICAL WIRING AND CONTACTS FOR WEAR	0.364	___	_______
30233	INSPECT AND LUBRICATE MOTOR GEARBOX	0.154	___	_______
30234	ADJUST LIMIT SWITCH	0.172	___	_______
30235	INSPECT AND LUBRICATE CHAIN	0.066	___	_______
30236	GREASE DOOR TRACKS	0.230	___	_______
30237	CLEAN UP AROUND DOOR AREA AFTER MAINTENANCE	0.051	___	_______
30238	FILL OUT MAINTENANCE RECORD/REPORT	0.017	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
	TOTAL EPS HOURS	_______	___	_______

KETTLE, STEAM; FIXED

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
55651	CHECK STEAM KETTLE FOR PROPER OPERATION	0.063	___	_______
55652	CHECK OPERATION OF PRESSURE REGULATING VALVE PRESSURE GAUGE, SAFETY VALVE, AND DRAIN VALVE. REPLACE HAND WHEELS AND "O" RINGS WHEN REQUIRED	0.084	___	_______
55653	INSPECT COVER AND HINGES ON UNITS SO EQUIPPED. LUBRICATE HINGE	0.041	___	_______
55654	CHECK PIPING FOR LEAKS AND DAMAGE. TIGHTEN FITTINGS TO STOP STEAM LEAKS IF REQUIRED	0.065	___	_______
55655	CHECK AND CLEAN STEAM TRAP AND STRAINER ON DIRECT CONNECTED STEAM UNITS	0.235	___	_______
55656	CHECK PILOTS AND FLAME ON GAS BURNER OPERATED SELF CONTAINED UNITS	0.065	___	_______
55657	FILL OUT MAINTENANCE RECORD/REPORT	0.017	___	_______
________	______________________________	_______	___	_______
________	______________________________	_______	___	_______
________	______________________________	_______	___	_______
________	______________________________	_______	___	_______
________	______________________________	_______	___	_______
________	______________________________	_______	___	_______
________	______________________________	_______	___	_______
________	______________________________	_______	___	_______
________	______________________________	_______	___	_______
	TOTAL EPS HOURS	_______	___	_______

PEELER, VEGETABLE

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
55801	CHECK VEGETABLE PEELER FOR PROPER OPERATION. (INCLUDES REMOVING/INSTALLING ACCESS PANEL)	0.079	___	_______
55802	CHECK MOTOR AND MOTOR BEARINGS FOR OVERHEATING BY HAND TOUCH	0.030	___	_______
55803	CHECK SWITCHES AND CONTROLS FOR DAMAGE AND PROPER OPERATION	0.011	___	_______
55804	LUBRICATE VEGETABLE PEELER BY LUBRICATING BUSHINGS AND FILLING GREASE CUP	0.048	___	_______
55805	CHECK DOOR FOR LOOSE HINGE AND LATCH FITTINGS. ADJUST IF REQUIRED	0.005	___	_______
55806	CLEAN VEGETABLE AND FRUIT PEELER THOROUGHLY OF DUST, GREASE, AND FOOD PARTICLES	0.011	___	_______
55807	INSPECT PIPING AND VALVES FOR LEAKS	0.059	___	_______
55808	INSPECT ABRASIVE DISK	0.014	___	_______
55809	TIGHTEN OR REPLACE LOOSE, MISSING, OR DAMAGED NUTS, BOLTS, OR SCREWS	0.004	___	_______
55810	CHECK BELT FOR PROPER TENSION AND ALIGNMENT, ADJUST OR REPLACE AS REQUIRED	0.022	___	_______
55811	FILL OUT MAINTENANCE RECORD/REPORT	0.017	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
	TOTAL EPS HOURS	_______	___	_______

STANDARD NUMBER - 55525 PG. 255

MIXER, FLOOR

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
55526	CHECK WITH OPERATING PERSONNEL FOR ANY KNOWN DEFICIENCIES	0.034	___	_______
55527	TURN MIXER ON, ALLOW TO RUN AND VARY SPEED TO CHECK OPERATION	0.052	___	_______
55528	CHECK MIXER FOR ALIGNMENT AND VIBRATION, ALIGN IF NECESSARY	0.025	___	_______
55529	CHECK OIL LEVEL IN TRANSMISSION, ADD AS REQUIRED	0.110	___	_______
55530	DRAIN AND REFILL OIL IN TRANSMISSION (1 QT.)	0.012	___	_______
55531	LUBRICATE MIXER-GEARS, BOWL LIFT MECHANISM AND 4 ZERK FITTINGS	0.032	___	_______
55532	CHECK BELT, ADJUST TENSION AND/OR PULLEY AS REQUIRED	0.022	___	_______
55533	REPLACE BELT IF REQUIRED	0.220	___	_______
55534	CLEAN MACHINE THOROUGHLY OF DUST, GREASE AND FOOD PARTICLES	0.023	___	_______
55535	CHECK MIXER MOTOR, SWITCHES, AND CONTROLS, CHECK MOTOR AND BEARING FOR OVERHEATING	0.030	___	_______
55536	INSPECT PIPING AND VALVES FOR LEAKS, IF UNIT IS EQUIPPED WITH WATER TANK	0.059	___	_______
55537	INSURE ANCHOR BOLTS ARE TIGHT	0.008	___	_______
55538	TIGHTEN OR REPLACE LOOSE, MISSING OR DAMAGED NUTS, BOLTS OR SCREWS	0.004	___	_______
55539	CLEAN AND TREAT CORROSION (PER SQ. FT.)	0.041	___	_______
55540	FILL OUT MAINTENANCE RECORD/REPORT	0.017	___	_______
	TOTAL EPS HOURS	_____	___	_______

STANDARD NUMBER - 55150 PG. 224

OVEN, CONVECTION

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
55151	CHECK DOORS FOR WARPING AND ALIGNMENT	0.005	___	_______
55152	CHECK PIPING AND VALVES FOR LEAKS	0.059	___	_______
55153	TIGHTEN AND REPLACE ANY LOOSE NUTS, BOLTS, OR SCREWS	0.004	___	_______
55154	CHECK PILOT AND ADJUST IF REQUIRED. CHECK GAS BURNER FOR UNIFORM FLAME	0.064	___	_______
55155	CHECK ELEMENT, SWITCHES, CONTROLS AND WIRING ON ELECTRICALLY HEATED UNITS FOR DEFECTS	0.092	___	_______
55156	REMOVE ACCESS PANEL, CHECK FAN BLADES AND FAN MOTOR	0.092	___	_______
55157	CHECK SEALS AROUND DOORS, LUBRICATE HINGES (3)	0.016	___	_______
55158	CHECK CALIBRATION OF THERMOSTAT	0.338	___	_______
55159	FILL OUT MAINTENANCE RECORD/REPORT	0.017	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
	TOTAL EPS HOURS	_______	___	______

FOOD SLICER

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
55351	CLEAN MACHINE THOROUGHLY OF DUST, GREASE, AND FOOD PARTICLES	0.011	___	_______
55352	TIGHTEN OR REPLACE LOOSE, MISSING OR DAMAGED NUTS, BOLTS, OR SCREWS	0.004	___	_______
55353	LUBRICATE FOOD SLICER AS REQUIRED. USE MINERAL OIL ON PARTS THAT COME IN CONTACT WITH FOOD	0.023	___	_______
55354	CHECK CONDITION OF BLADE, BLADE GUARD, GUIDES, AND CONTROLS	0.012	___	_______
55355	CHECK MOTOR AND MOTOR BEARINGS FOR OVERHEATING	0.030	___	_______
55356	ADJUST BLADE, MOTOR OR CARRIAGE	0.024	___	_______
55357	CHECK LUBRICANT IN GEAR CASE, ADD AS REQUIRED	0.042	___	_______
55358	CHECK SHARPENING STONES, REMOVE OLD AND INSTALL NEW AS REQUIRED (PER 2 EACH)	0.010	___	_______
55359	FILL OUT MAINTENANCE RECORD/REPORT	0.017	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
	TOTAL EPS HOURS	_______	___	_______

COFFEE MAKER/URN

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
55101	CHECK THERMOSTAT AND TEMPERATURE GAUGE ON COFFEE URN/MAKER. CALIBRATE IF NECESSARY	0.352	___	_______
55102	CHECK PILOTS AND FLAME ON GAS OPERATED MAKERS/URNS	0.029	___	_______
55103	CHECK WORKING PRESSURE ON STEAM OPERATED UNIT	0.004	___	_______
55104	CHECK ELECTRICAL CONNECTIONS AND WIRING FOR DEFECTS. TIGHTEN LOOSE CONNECTIONS	0.092	___	_______
55105	CHECK FOR CLOGGED OR DEFECTIVE STEAM TRAP	0.077	___	_______
55106	INSPECT AND CLEAN STEAM STRAINER	0.159	___	_______
55107	EXAMINE EQUIPMENT, VALVES, AND PIPING FOR LEAKS	0.059	___	_______
55108	INSPECT URN/COFFEE MAKER FOR LEAKS AT WATER GAUGES GLASSES AND AT VALVES. REPACK VALVES IF NECESSARY	0.035	___	_______
55109	TIGHTEN OR REPLACE LOOSE, MISSING OR DAMAGED NUTS, BOLTS OR SCREWS	0.004	___	_______
55110	LUBRICATE WATER FILTER VALVE, CHECK "0" RINGS, TIGHTEN AS REQUIRED	0.025	___	_______
55111	CHECK OPERATION OF LIGHTS	0.021	___	_______
55112	CHECK TIMER MECHANISM AND OPERATION OF URN	0.014	___	_______
55113	CHECK OPERATION OF ON/OFF SWITCH	0.006	___	_______
55114	FILL OUT MAINTENANCE RECORD/REPORT	0.017	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
	TOTAL EPS HOURS	_______	___	_______

GRILL

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
55501	TIGHTEN OR REPLACE ANY LOOSE NUTS, BOLTS, SCREWS. REPLACE BROKEN KNOBS.	0.005	___	_______
55502	CHECK PIPING AND VALVES ON GAS OPERATED UNITS FOR LEAKS	0.059	___	_______
55503	CHECK PILOT ON GAS OPERATED UNITS AND ADJUST IF REQUIRED. CHECK GAS BURNERS FOR UNIFORM FLAME	0.061	___	_______
55504	CHECK CONNECTIONS AND WIRING ON ELECTRICALLY OPERATED UNITS. TIGHTEN CONNECTIONS	0.092	___	_______
55505	TURN MAIN POWER SUPPLY ON/OFF	0.006	___	_______
55506	CHECK POWER PLUG FOR LOOSE WIRES, TIGHTEN AS REQUIRED	0.006	___	_______
55507	CHECK CALIBRATION OF THERMOSTATS	0.352	___	_______
55508	FILL OUT MAINTENANCE RECORD/REPORT	0.017	___	_______
________	______________________________	_______	___	_______
________	______________________________	_______	___	_______
________	______________________________	_______	___	_______
________	______________________________	_______	___	_______
________	______________________________	_______	___	_______
________	______________________________	_______	___	_______
________	______________________________	_______	___	_______
________	______________________________	_______	___	_______
	TOTAL EPS HOURS	_______	___	_______

STANDARD NUMBER - 55700 PG. 269

STEAM TABLE

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
55701	INSPECT WATER COMPARTMENT, STEAM COIL, VALVES AND PIPING FOR LEAKS	0.090	___	_______
55702	CHECK AND CLEAN STEAM TRAP AND STRAINER ON DIRECT CONNECTED STEAM UNITS	0.235	___	_______
55703	CHECK OPERATION OF PRESSURE REGULATING VALVE AND GAUGE ON DIRECT CONNECTED STEAM UNITS	0.027	___	_______
55704	CHECK PILOTS AND FLAME ON GAS BURNER OPERATED UNITS	0.065	___	_______
55705	CHECK INSULATORS, CONNECTIONS, AND WIRING ON ELECTRICALLY OPERATED UNITS. TIGHTEN LOOSE CONNECTIONS	0.092	___	_______
55706	CHECK CONDITION OF COVERS AND RECEPTACLES	0.019	___	_______
55707	CHECK THERMOSTAT AND TEMPERATURE GAUGE, CALIBRATE THERMOSTAT IF NECESSARY	0.117	___	_______
55708	FILL OUT MAINTENANCE RECORD/REPORT	0.017	___	_______
________	____________________	_______	___	_______
________	____________________	_______	___	_______
________	____________________	_______	___	_______
________	____________________	_______	___	_______
________	____________________	_______	___	_______
________	____________________	_______	___	_______
________	____________________	_______	___	_______
	TOTAL EPS HOURS	_______	___	_______

STANDARD NUMBER - 55750 PG. 273

TOASTER, ROTARY

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
55751	TEST OPERATION OF TOASTER BY TOASTING SAMPLE SLICE OF BREAD	0.026	___	_______
55752	CLEAN TOASTER	0.011	___	_______
55753	CHECK VALVES AND PIPING FOR LEAKS ON GAS OPERATED UNITS	0.059	___	_______
55754	CHECK PILOT LIGHT AND BURNER FLAME ON GAS OPERATED UNITS. ADJUST WHEN REQUIRED	0.013	___	_______
55755	CHECK HEATING ELEMENTS ON ELECTRICALLY OPERATED UNITS	0.011	___	_______
55756	CHECK ELECTRIC INSULATORS, CONNECTIONS, AND WIRING (INCLUDES REMOVING ACCESS PANEL)	0.092	___	_______
55757	INSPECT ALIGNMENT OF BASKETS AND CONVEYOR CHAINS. ALIGN IF NECESSARY	0.018	___	_______
55758	LUBRICATE CHAIN	0.016	___	_______
55759	CHECK MOTOR AND MOTOR BEARINGS FOR OVERHEATING BY HAND TOUCH	0.030	___	_______
55760	TIGHTEN OR REPLACE LOOSE, MISSING, OR DAMAGED NUTS, BOLTS, OR SCREWS	0.004	___	_______
55761	LUBRICATE MOTOR (2 OIL HOLES)	0.036	___	_______
55762	FILL OUT MAINTENANCE RECORD/REPORT	0.017	___	_______
________	____	_______	___	_______
________	____	_______	___	_______
	TOTAL EPS HOURS	_______	___	_______

STANDARD NUMBER - 55200 PG. 228

DEEP FAT FRYER, CONVENTIONAL TYPE

CHECKPNT	CHECKPOINT DESCRIPTION	EPS HRS	OCC	TOT HRS
55201	CLEAN MACHINE THOROUGHLY OF DUST, GREASE, AND FOOD PARTICLES	0.011	___	_______
55202	EXAMINE COMPARTMENTS, VALVES, AND PIPING FOR LEAKS	0.059	___	_______
55203	CHECK PILOT AND FLAME ON GAS OPERATED DEEP FAT FRYERS	0.004	___	_______
55204	CHECK THERMOSTAT WITH THERMOMETER. CALIBRATE IF NECESSARY	0.338	___	_______
55205	CHECK ELEMENTS, SWITCHES, CONTROLS, CONTACTS, AND WIRING ON ELECTRICALLY HEATED UNITS FOR DEFECTS	0.019	___	_______
55206	CHECK BASKET OR RACK FOR BENDS OR DEFECTS STRAIGHTEN BENDS WHEN NECESSARY	0.010	___	_______
55207	TIGHTEN OR REPLACE LOOSE, MISSING OR DAMAGED NUTS, BOLTS, OR SCREWS	0.004	___	_______
55208	FILL OUT MAINTENANCE RECORD/REPORT	0.017	___	_______
________	____________________________________	_______	___	_______
________	____________________________________	_______	___	_______
________	____________________________________	_______	___	_______
________	____________________________________	_______	___	_______
________	____________________________________	_______	___	_______
________	____________________________________	_______	___	_______
________	____________________________________	_______	___	_______
	TOTAL EPS HOURS	_______	___	_______

APPENDIX B

ESTIMATING FORMULAS AND CONVERSION FACTORS

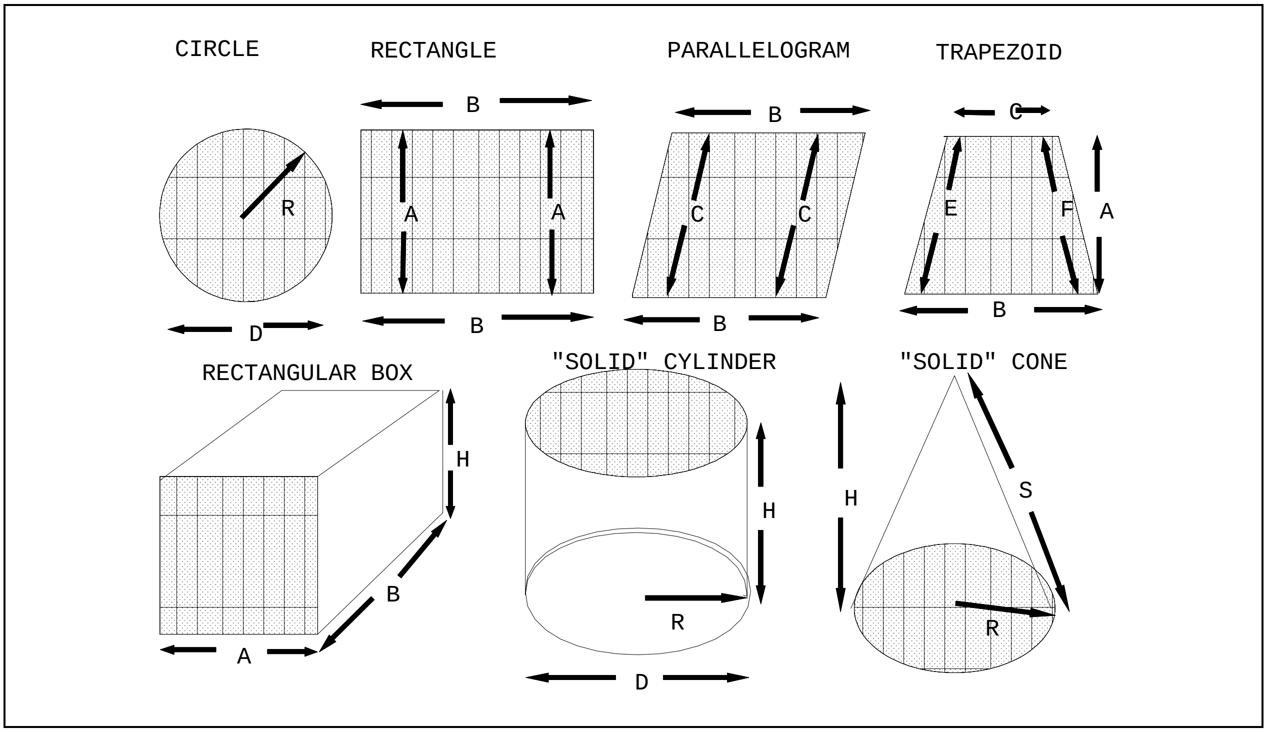
P&E FORMULAS, TERMS AND SYMBOLS

AR =	Area	= Length X Width
CR =	Circumference	= Distance around the edge of a circle's perimeter
CB =	Cubed	= A number multiplied by its square: (5)CB=5X5X5=125
D =	Diameter	= 2 X Radius. The length through the center of a circle.
H =	Height	= Volume divided by area.
N =	Number of sides	= Example: A Pentagon has five sides (N=5)
PI =	3.1416	= The ratio of the Circumference to the Diameter of a circle. Used as a constant in a wide range of math prroblems.
R =	Radius	= 1/2 Diameter or the distance from circle center to the edge
SQ =	Squared	= (No.) Multiplied by itself: (5)SQ=5X5=25
√ =	Square Root	= A divisor of a quantity that when squared gives that quantity. ie.√6= 2.4494897. 2.4494897 X 2.4494897 = 6
V =	Volume	= Length X Width X Height
X =	Multiply By	= Example: 20 X 5 = 100
/ =	Divide By	= Example: 100 / 20 = 5

CONVERSION CALCULATIONS FOR LENGTHS/PLANES/SOLIDS

FT X FT = (FT)SQ = SF "Square Feet"
FT X SF = (FT)CB = CF "Cubic Feet"
CF / FT = (FT X FT X FT) / FT = SF "Square Feet"

GEOMETRIC FIGURES



GEOMETRIC FORMULAS

FIGURE TYPE	AREA	CIRCUMFERENCE	VOLUME
CIRCLE-RADIUS	PI X (R)SQ	2 X PI X R	
CIRCLE-DIAMETER	PI X (D/2)SQ	PI X D	
SPHERE	PI X (D)SQ		1/6 X PI X (D)CB
CYLINDER	PI X D X H	PI X D	PI X (R)SQ X H
CONE	PI X R X S		1/3 X PI X (R)SQ X H
PYRAMID	1/2 X B X S X N		1/3 X BASE AREA X H
RECTANGLE	A X B	2 X (A+b)	
PARALLELOGRAM	A X B	2 X (B+C)	
TRAPEZOID	1/2 X A X (B+C)	B + C + E + F	
TRIANGLE	1/2 X A X B	B + C + D	
RECTANGULAR BOX	2 X (AB+AH+BH)		A X B X H

CONVERSION FACTORS

MULTIPLY	BY	TO OBTAIN
Acres	43560	sq ft
Barrels-oil	42	gals of oil
Board foot	12 X 12 X 1	cu in
Centimeters	0.3937	inches
cm	0.01	meters
cm	10	millimeters
Cms/second	1.969	ft/min
cms/s	0.03281	ft/sec
cms/s	0.036	km/hr
cms/s	0.6	meters/min
cms/s	0.02237	miles/hr
Cubic Feet	28317	cubic cms
cu ft	1728	cu ins
cu ft	0.02832	cu meters
cu ft	0.03704	cu yds
cu ft	7.48052	gals
cu ft	28.32	liters
cu ft	59.84	pints
cu ft	29.92	quarts
Cubic inches	16.39	cubic cms
cu in	0.03463	pints
cu in	0.01732	quarts
Cubic meters	35.31	cu ft
cu M	61.023	cu ins
cu M	1.308	cu yds
cu M	264.2	gals
cu M	2113	pints
cu M	1057	quarts
Cubic yards	27	cu ft
cu yd	46.656	cu ins
cu yd	0.7646	cu meters
cu yd	202.0	gals
cu yd	764.6	liters
cu yd	1616	pints
cu yd	807.9	quarts
Decimeters	0.1	meters
Degs (Angle)	60	minutes
degs(A)	0.01745	radians
degs(A)	3600	secs
Degrees Sec	0.01745	radian/sec
degs/sec	0.1667	revs/min
degs/sec	0.002778	revs/sec
Fathoms	6	ft
Feet	30.48	cms
ft	12	ins
ft	0.3048	meters
ft	1/3	yds
Feet of Water	0.08048	kgs/sq cm
Meters/min	0.05468	ft/sec
meters/min	0.06	kms/hr
meters/min	0.03728	miles/hr
Miles	5280	ft
miles	1.609	km
Miles/Hr	44.70	cms/sec
miles/hr	88	ft/min
miles/hr	1.467	ft/sec
miles/hr	1.609	kms/hr
miles/hr	0.8684	knots
miles/hr	26.82	meters/min
Millimeters	0.1	cms
mms	0.03937	ins
Ounces	16	drams
ozs	437.5	grains
ozs	0.0625	lbs
ozs	28.349527	grams
ozs	0.9115	ozs(troy)
ozs	$2.790x10^{-5}$	tons(long)
ozs	$2.835x10^{-5}$	tons(metric)
Ozs (fluid)	1.805	cu in
ozs(fluid)	0.02957	liters
Pounds	16	ozs
lbs	256	drams
lbs	7000	grains
lbs	0.0005	tons(short)
lbs	453.5924	grams
lbs	1.21528	lbs(troy)
lbs	14.5833	0zs(troy)
Pounds of Water	0.01602	cu ft
lbs of water	27.68	cu in
lbs of water	0.1198	gals
Pounds/Sq In	2.307	ft water
Square Foot	144	sq in
Square Mile	640	acres
Square Yard	9	sq ft
Tons(Long)	1016	kgs
tons(long)	2240	lbs
tons(long)	1.12000	tons(short)
Tons(Short)	2000	lbs
tons(short)	32000	ozs
tons(short)	907.18486	kgs
tons(short)	0.89287	tons(long)
tons(short)	0.90718	tons(metric)
Watts	0.05692	BTUs/min
watts	44.26	ft-lbs/min
watts	0.7376	ft-lbs/sec
watts	$1.341x10^{-3}$	hp
watts	10^{-3}	kws
Watt-Hours	3.415	BTUs
watt-hrs	2655	ft-lbs
watt-hrs	10^{-3}	kw-hrs
Yard	3	ft
yd	36	in

DECIMAL EQUIVALENTS OF COMMON FRACTIONS

		1/64	=	0.015625			33/64	=	.515625
	1/32	2/64	=	.031250		17/32	34/64	=	.531250
		3/64	=	.046875			35/64	=	.546875
1/16	2/32	4/64	=	.062500	9/16	18/32	36/64	=	.562500
		5/64	=	.078125			37/64	=	.578125
	3/32	6/64	=	.093750		19/32	38/64	=	.593750
		7/64	=	.109375			39/64	=	.609375
1/8	4/32	8/64	=	.125000	5/8	20/32	40/64	=	.625000
		9/64	=	.140625			41/64	=	.640625
	5/32	10/64	=	.156250		21/32	42/64	=	.656250
		11/64	=	.171875			43/64	=	.671875
3/16	6/32	12/64	=	.187500	11/16	22/32	44/64	=	.687500
		13/64	=	.203125			45/64	=	.703125
	7/32	14/64	=	.218750		23/32	46/64	=	.718750
		15/64	=	.234375			47/64	=	.734375
1/4	8/32	16/64	=	.250000	3/4	24/32	48/64	=	.750000
		17/64	=	.265625			49/64	=	.765625
	9/32	18/64	=	.281250		25/32	50/64	=	.781250
		19/64	=	.296875			51/64	=	.796875
5/16	10/32	20/64	=	.312500	13/16	26/32	52/64	=	.81250
		21/64	=	.328125			53/64	=	.828125
	11/32	22/64	=	.343750		27/32	54/64	=	.843750
		23/64	=	.359375			55/64	=	.859375
3/8	12/32	24/64	=	.375000	7/8	28/32	56/64	=	.875000
		25/64	=	.390625			57/64	=	.890625
	13/32	26/64	=	.406250		29/32	58/64	=	.906250
		27/64	=	.421875			59/64	=	.921875
7/16	14/32	28/64	=	.437500	15/16	30/32	60/64	=	.937500
		29/64	=	.453125			61/64	=	.953125
	15/32	30/64	=	.468750		31/32	62/64	=	.968750
		31/64	=	.484375			63/64	=	.984375
1/2	16/32	32/64	=	.500000	1	32/32	64/64	=	1.00000

LUMBER SIZES & BOARD FOOTAGE

Nominal Size (in)	Actual Size (in)	BOARD LENGTH IN FEET 8'	10'	12'	14'	16'	18'	20'	24'
1 X 2	3/4 x 1-1/2	1-1/3	1-2/3	2	2-1/3	2-2/3	3	3-1/2	4
1 X 3	3/4 x 2-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	6
1 X 4	3/4 x 3-1/2	2-2/3	3-1/3	4	4-2/3	5-1/3	6	6-2/3	8
1 X 6	3/4 x 5-1/2	4	5	6	7	8	9	10	12
1 X 8	3/4 x 7-1/4	5-1/3	6-2/3	8	9-1/3	10-2/3	12	13-1/3	16
1 X 10	3/4 x 9-1/4	6-2/3	8-1/3	10	11-2/3	13-1/3	15	16-2/3	20
1 X 12	3/4 x 11-1/4	8	10	12	14	16	18	20	24
2 X 4	1-1/2 x 3-1/2	5-1/3	6-2/3	8	9-1/3	10-2/3	12	13-1/3	16
2 X 6	1-1/2 x 5-1/2	8	10	12	14	16	18	20	24
2 X 8	1-1/2 x 7-1/4	10-2/3	13-1/3	16	18-2/3	21-1/3	24	26-2/3	32
2 X 10	1-1/2 x 9-1/4	13-1/3	16-2/3	20	23-1/3	26-2/3	30	33-1/3	40
2 X 12	1-1/2 x 11-1/4	16	20	24	28	32	36	40	48
4 X 4	3-1/2 x 3-1/2	10-2/3	13-1/3	16	18-2/3	21-1/3	24	26-2/3	32
4 X 6	3-1/2 x 5-1/2	16	20	24	28	32	36	40	48
6 X 6	5-1/2 x 5-1/2	24	30	36	42	48	54	60	72
8 X 8	7-1/4 x 7-1/4	42-2/3	53-1/3	64	74-2/3	85-1/3	96	106-2/3	128

READ BOARD FOOTAGE ABOVE

APPENDIX C

MATERIAL ESTIMATES

MATERIAL DEVELOPMENT

MATERIAL	UNIT/ MEASURE	UNIT APPLIED	DESCRIPTOR
ACETYLENE	cu ft	# cu ft	Approximate 2 to 1 ratio of oxygen to acetylene.
ADHESIVE			
Acoustical Tile	gallon	.013 gal/sq ft	1 gallon covers 75 sq ft.
Contact Cement	gallon	.013 gal/sq ft	1 gallon covers 75 sq ft.
Floor Tile	gallon	.025 gal/sq ft	1 gallon per 40 sq ft coverage.
Grout	pound	.5 lbs/sq ft	50 lbs per 100 sq ft coverage.
Grout Additive	gallon	.01 gal/sq ft	1 gallon per 100 sq ft.
Insulation	ounce	1.56 oz/sq ft	1 pint (16 oz) covers up to 25 sq ft depending on porosity of materials to be bonded (on product).
ASPHALT			
Tack Coat	gallon	.2 gal/sq yd	Straight Usage.
Bituminous Mix	ton	.055 ton/sy 1"	2 ton per cu yd.
	ton	.165 ton/sy 3"	2 ton per cu yd.
	ton	.222 ton/sy 4"	2 ton per cu yd.
Crack Sealer	pound	10 pound/100 lf	10 pounds per gallon (average).
ASPHALT MIX	ounce	4 ounce/ft	Based on " deep x 1" wide x 12" long crack.
		.667 oz/cu in	Requires 4 ox = 4 oz/6 cu in = .667 oz/cu in.
BALLAST	ton	1.5 ton/cu yd	#4 ballast - 1.5 tons occupies approx 1 cu yd of space.
BRICK	each	112 lbs./cu ft	6-1/2 bricks (w/3/8" joint per cu ft.) 1233 std. bricks required for 100 sq ft of wall (8" thick wall; 1/2" joints)
CAULKING COMPOUND	tube	.02 tube/ft	Tubes of caulking supplied in 11 oz size. One bead of 50 ln ft per tube. 1 tube/50 ft = .02 tube/ft.
CEILING TILE	each	2' X 4' per tile	64 0r 80 sq ft per carton
CEMENT			
Concrete Mix - Regular or Hydraulic (with or without gravel)	pound	120 lbs/cu ft	80 lb bag = .667 cu ft = 120 lbs/cu ft = .069 lb/cu in.
Mortar mix - Brick	pound	.069 lbs/cu in	60 bricks/80 lb bag.
Mortar Mix - Block	pound	1.33 lbs/brick	27 blocks/80 lb bag.
Mortar Mix - Floor Tile	pound	2.96 lbs/block	Average is 1" thick for tile bed = 1 sq ft x 1" = .125 cu ft of mortar. 80 lb bag = .667 cu ft = 120
PVC or ABS	ounce	15 lbs/sq ft	lbs/cu ft x .125 cu ft/sq ft = 15 lbs/sq ft.
		# ounces	From Yardly catalog per joint or socket
			Pipe Size — Ounces
			" — .084
			" — .133
			1" — .160
			1" — .228
			1" — .320
			2" — .530
			2" — .640
			3" — .800
			4" — 1.00
			5" — 1.33
			6" — 2.67
			8" — 8.00

MATERIAL DEVELOPMENT

MATERIAL	UNIT/ MEASURE	UNIT APPLIED	DESCRIPTOR
Waterproof	ounce	.117 sq ft/ounce	15 sq ft per gallon - heavy coat (on product)
CLEANER			
Bowl	ounce	4 ounce/bowl	Manufacturer's Recommendation
Powder	ounce	.1 oz/basin	Manufacturer's Recommendation
Glass	ounce	.5 oz/100 sq ft	Manufacturer's Recommendation
CONCRETE	cu yd	1 cu yd will cover about 300 sq ft/1" thick	Small job mix: 6 (94 lb) bags portland cement 1,250 lbs. of concrete sand 1,900 lbs. of gravel or crushed stone 30 gal. of water, approx. 5 gal per bag.
CONCRETE BLOCK	each	8" X 8" X 16" nom. 7-5/8" X 7-5/8" X 15-5/8" actual size	112.5 blocks required for 100 sq ft of wall
DETERGENT	ounce	1.10 oz/100 sq ft	3 to 1 mixture - 3,000 sq ft/gallon
		.006 oz/ln ft	1 sq ft = 2 ln ft
DISINFECTANT	ounce	2 oz/bowl	Manufacturer's Recommendation
DRYWALL COMPOUND			
	pound	.062 lbs/sq ft	4" x 36" of compound = 1 sq ft coverage 1,000 sq ft for 62 lbs or 5 gallons
EPOXY SEALER	quart	.094 quart/ft	3 ounces per foot
GASKET	sq ft	sq ft req'd	Gasket material is purchased in various size rolls and sheets which also vary with thickness. Common unit of measure is sq ft
	each	each	Gaskets used for specific equipment applications are purchased pre-formed and cut
GLAZING	ounce	.25 ounce/ln ft	Coverage rate of 16 ounces per 64 ln ft
GREASE	pound	# pounds	Major applications from cans in pounds
	ounce	# ounces	Smaller applications - maintenance type normally from 14 - 16 oz tubes
HERBICIDE			
Weed Control:			
Sidewalks	ounce	.184 oz/100 ln ft	2 quart per 100 gallon water
Fenceline	ounce	.002 oz/ln ft	3 quart per 100 gallon water (initial)
	ounce	.001 oz/ln ft	1 quart per 100 gallon water (follow-up)
Improved Areas	ounce	.016 oz/500 sf	2 quart per 100 gallon water
Shrubs	ounce	.026 oz/shrub	1.33 oz per 5 gallon water (10 shrubs/gallon) 50% in size
INSECTICIDES			
Household	ounce	1.33 oz/100 sf	2.67 oz per gallon
Open Areas	ounce	2.67 oz/1000 sf	2.67 oz per gallon
Office	ounce	.333 oz/100 sf	2.67 oz per gallon
Baseboards	ounce	2.67 oz/100 sf	2.67 oz per gallon
Termites	ounce	.320 oz/quart	1 gallon per 100 gallon
Bait	box	.013 box/trap	80 baits per box
Mosquito	ounce	1.5 oz/min	Straight 95% malathion (fogging)
Fire Ants	pound	.2 lb./mound	5 tablespoons per mound (25/pound)

MATERIAL DEVELOPMENT

MATERIAL	UNIT/ MEASURE	UNIT APPLIED	DESCRIPTOR
INSULATION, BATT	batt, rolled	R11, Faced,15"wide	3-1/2" thick, 88.12 sq ft per roll
		R11, Faced,23"wide	3-1/2" thick, 135.12 sq ft per roll
		R13, Faced,15"wide	3-1/2" thick, 88.12 sq ft per roll
		R19, Faced,15"wide	6-1/4" thick, 48.96 sq ft per roll
		R19, Faced,23"wide	6-1/4" thick, 75.07 sq ft per roll
		R25, Unfaced,15"w	8" thick, 22.3 sq ft per roll
		R25, Unfaced,23"w	8" thick, 34.5 sq ft per roll
		R30, Unfaced,16"w	9-1/2" thick, 58.67 sq ft per pkg.
		R30, Unfaced,24"w	9-1/2" thick. 80 sq ft per pkg.
LEAD			
CI Water Pipe	pound	# pounds	From Hajoca Corporation catalog, the lead req'd for joints is as follows:

Pipe Size (In)	#lbs Lead (Water)	#lbs Lead (Sewer)
2	---	1.15
3	6.0	1.60
4	7.5	2.04
6	10.25	2.13
8	13.25	6.17
10	16.00	7.75
12	19.00	10.47
14	22.00	.00
15	.00	17.67
16	30.00	(12 OZ LEAD
18	33.80	PER 1" DIA)
20	37.00	
24	44.00	
30	54.25	
36	64.75	
42	75.25	
48	85.50	

MATERIAL	UNIT/ MEASURE	UNIT APPLIED	DESCRIPTOR
NAILS			
2D Common	pound	.0012 lb/nail	847 nails per pound
2D Finish	pound	.0011 lb/nail	932 nails per pound
4D Common	pound	.0032 lb/nail	316 nails per pound
4D Common	pound	.0029 lb/nail	348 nails per pound
6D Common	pound	.0055 lb/nail	181 nails per pound
6D Finish	pound	.0050 lb/nail	199 nails per pound
8D Common	pound	.0055 lb/nail	181 nails per pound
8D Finish	pound	.0094 lb/nail	106 nails per pound
10D Common	pound	.0085 lb/nail	117 mails per pound
10D Finish	pound	.0145 lb/nail	69 nails per pound
10D Finish	pound	.0132 lb/nail	76 nails per pound
12D Common	pound	.0159 lb/nail	63 nails per pound

MATERIAL DEVELOPMENT

MATERIAL	UNIT/ MEASURE	UNIT APPLIED	DESCRIPTOR
12D Finish	pound	.0145 lb/nail	69 nails per pound
16D Common	pound	.0204 lb/nail	49 nails per pound
16D Finish	pound	.0185 lb/nail	54 nails per pound
20D Common	pound	.0294 lb/nail	31 nails per pound
20D Finish	pound	.0055 lb/nail	34 nails per pound
Common Blued	pound	.0055 lb/nail	Blued nails are usually #6
OAKUM			
Water Pipe	pound	# pounds	From Hajoca Corp. Pipe Catalog:
			Pipe Size (In) / #lbs Oakum (Water) / #lbs Oakum (Sewer)
			2 / --- / .14
			3 / .18 / .16
			4 / .21 / .18
			6 / .31 / .21
			8 / .44 / .44
			10 / .53 / .53
			12 / .61 / .61
			14 / .81 / .00
			16 / .94 / .94
			18 / 1.00
			20 / 1.25
			24 / 1.50
			30 / 2.06
			36 / 3.00
			42 / 3.62
			48 / 4.37
OIL			
Spray Base Material	gallon	.006 gal/sq ft	Straight usage
Light Lubricant	ounce	# ounces	Light applications in cans or spray
Filling	quart	# quarts	Heavier applications for machine cups or oil in pumps
OXYGEN	cu ft	# cu ft	Various size containers with common measure in cubic feet.
PACKING	pound	# pounds	Sold by the pound. Application rate is estimator's experience.
PAINT			
Spray Can	ounce	1.00 oz/sq ft	Spray can of 12 ounces covers approximately 12 sq ft of surface area
Finish	gallon	.0033 gal/sq ft	Maximum coverage for interior, exterior, latex or oil paint on non-porous, smooth surface is 400 sq ft/ gal. Estimated coverage is 75% of maximum or 300 sq ft/gal maximum coverage based on the following paints
			Type Paint / Federal Specification
			Exterior Latex / MIL-P-28578
			Exterior Oil / TT-P-24
			Interior Latex / TT-P-29
			Interior Oil / TT-E-508
Finish (Metal)	gallon	.0029 gal/sq ft	Maximum coverage for enamel finishes such as federal specification TT-E-489 is 450 sq ft/gal. This type of paint is more likely to be used on metal surfaces. Estimated coverage is approximately 75% or 350 sq ft/gal.

MATERIAL DEVELOPMENT

MATERIAL	UNIT/ MEASURE	UNIT APPLIED	DESCRIPTOR
Primer (General)	gallon	.0033 gal/sq ft	Maximum coverage for interior, exterior, latex and oil primers on non-porous, smooth surface is 400 sq ft/gal. Estimated coverage is 75% of maximum or 300 sq ft/gal. Maximum coverage based on the following paints: Type Paint — Federal Specification Exterior Latex — TT-P-1984 Exterior Oil — TT-P-25 Interior Oil — TT-P-650 Interior Oil — TT-E-543
Primer (Red Lead & Zinc Chromate)	gallon	.0029 gal/sq ft	Maximum coverage for red lead (TT-P-31) and zinc chromate (TT-P-57) is 400 sq ft/gal. Estimated coverage on metal surfaces is about 85% or 350 sq ft/gal.
Primer (Acoustical Ceiling)	gallon	.0050 gal/sq ft	Maximum coverage for primer is 400 sq ft/gal. Estimated coverage for first time coverage of acoustical ceiling tile is 50% of maximum or 200 sq ft/gal.
Lettering Paint	gallon	.0050 gal/sq ft	Estimated coverage is 200 sq ft/gal.
Traffic Striping	gallon	.0025 gal/ln ft	Coverage rate for traffic striping paint (TT-P-85) is up to 133.3 sq ft/gal. Estimated coverage with machine application is 100% or 400 ln ft/gal using a 4" wide stripe.
Chain Link Fence	gallon	.0014 gal/sq ft	Coverage for chain link is estimated to be twice normal metal coverage of 350 sq ft/gal or 700 ft/gal using the roller system of application.
Aluminum (Waterproof Tar)	gallon	.0133 gal/sq ft	Estimated coverage is 75 sq ft/gal.
Shellac	gallon	.002 gal/sq ft	Estimated coverage is 500 sq ft/gal.
Thinner	gallon	12.5% of paint unit	Average recommended thinner to paint ratio is pt/gal or 15%. Paint Notes 1. Area of corrugated metal is 1.3 times flat surface sq ft. 2. Brush, roller, and spray painting method are estimated as having the same coverage rate. 3. Airless and conventional spray are estimates as having the same coverage rate. 4. Brush paint character is estimated at 50% of the maximum coverage of 400 sq ft/gal. 5. Brush paint shadow or second coat of character is estimated at 75% of 400 sq ft/gal. 6. Brush paint stencil character is estimated to be 50% of the maximum 400 sq ft/gal (same as rate for brush paint character). 7. Spray paint stencil character is estimated to be 35% of the maximum 400 sq ft/gal coverage rate or 150 sq ft/gal due to overspray. 8. The character "A" is used in estimating the quantity of paint used in lettering. 9. A 4" wide line is used for estimating traffic striping.

MATERIAL DEVELOPMENT

MATERIAL	UNIT/ MEASURE	UNIT APPLIED	DESCRIPTOR
PLASTER	pound	2 lb/sq ft	DT-274 1 batch/sq ft. 1 batch = 50 lb. 50 lb/sq ft = 2 lb/sq ft
PUTTY	pound	# pounds	Plumbers putty is sold by the pound in various size containers. Application varies.
RAGS	pound	.1 pound/rag	1 bail of #3 rags = 500 pcs and 50 lbs
REFRIGERANT			
A/C	pound	2.5 lbs/ton	Standard established by HVAC estimator for filling A/C units.
REINFORCEMENT BAR	size/length	36 ln ft/sq yd	#4 = " diameter - 21 feet long - 6" center.
ROOFING			
Shingles	bundle	# bundles	27 3-tab shingles per bundle covers approximately 33 1/3 sq. ft..
Tar	pound	.033 lbs/sq ft	Sold in various sizes by pound - 30 lbs per 100 sq ft/layer.
Cement	gallon	.037 gal/sq ft	1 gallon covers - 25.67 sq ft @ 1/16" thick.
Felt			
30 lbs	roll	.005 roll/sq ft	roll covers - 216 sq ft.
15 lbs	roll	.003 roll/sq ft	roll covers - 324 sq ft.
90 lbs	roll	.009 roll/sq ft	roll covers - 105 sq ft
SAND	ton	.042 ton/sy 1"	1.5 ton per cubic yard.
	ton	.126 ton/sy 3"	1.5 ton per cubic yard.
SANDBLAST SAND	ton	.025 ton	Commercial blast average surface - est 10 lb/sq ft.
	ton	.050 ton	White metal blast average surface - est 50 lb/sq ft.
SCREEN PRINTING			
Film	roll	# roll/sq in	150 ft per roll 42" wide = 75,6000 sq in/roll
Ink	gallon	.0026 gal/sq in	1 pint per 48 sq in
Retarder	gallon	.0026 gal/sq in	1 pint per 48 sq in
Thinner	gallon	.0026 gal/sq in	1 pint per 48 sq in
SEALER			
Concrete	ounce	.128 oz/sq ft	1,000 sq ft per gallon
SHAMPOO			
Carpet	ounce	1.78 oz/100 sf	8 ounce per 450 square feet
SHEET METAL	sheet	sheet	32 sq ft/sheet
SOLDER			
Electrical	pound	.003 lbs/joint	50/50 solder for electrical .093" dia. average is approximately 50' per round (sold by the pound). Average use per joint = 1.5". 1.5"/600"/lb = .003 lbs/1.5" joint.
Silver	pound	.002 lbs/inch in fitting	Silver solder sold by pound of 16 rods _"
SOLDER PASTE	pound	.003 lbs/joint	50 applications/2 oz can - .0025 pounds. 1 application = .003 pounds/joint
SOLVENT	ounce	# ounces	Solvent comes in various size cans, pints, gallons, drums. The number of ounces can be converted to any size ordered. 2 ounces - for small part(s) to 1 sq ft. 4 ounces - for medium part(s) to 2 sq ft. 8 ounces - for large part(s) to 4 sq ft.
SPACKLING	pound	5.95 lbs/cu ft	5 gallons = 62 lbs for 1000 sq ft coverage at _" thick = 62 lbs/10.42 cu ft = 5.95 lbs/cu ft.

MATERIAL DEVELOPMENT

MATERIAL	UNIT/ MEASURE	UNIT APPLIED	DESCRIPTOR
SPRAY METAL	pound	117 sq in/lb	Spray metal comes in varying size containers by the pound. Application is 3 lbs/8" dia. x 14" lg shaft to _" thk application. Area covered is 352 sq in per 3 lbs - 117 sq in/lb 1,000 small stapes/box.
STAPLES (SMALL)	box	# boxes	1,000 small staples/box.
STRIPPING SOLUTION	ounce	3.2 oz/100 sf	ratio 3 to 1 - 1,000 sq ft per gallon.
SWEEPING COMPOUND	pound	.500 lb/100 sf	100 pound per 20,000 square yard
TAPE			
Drywall	roll	.012 roll/sq ft	3 ft of tape/sq ft of compound roll = 250'.
Duct	roll	.006 roll/ft	Roll is 180'. 1 ft = 1/180 = .005 roll/ft.
Electrical	50 ft roll	.005 roll/appl .010 roll/appl .015 roll/appl	small wire = 3" per use = 3"/50' roll = .006 roll/use. med wire = 6" per use = 6"/50' roll = .010 roll/use. large wire = 9" per use = 9"/50' roll = .015 roll/use.
Sealant	roll	.004 roll/inch or # inch/260" roll	Roll of teflon sealant tape is 260". 1/260" = .004 roll/inch.
THERMITE			
Rail Weld Unit	each	1 unit/weld	Weld unit includes 35 lbs thermite, wick, starting thermite and mold. Will weld 1 joint of 115 lbs rail.
Extension Ring	each	20 welds/ring	One thermite extension ring is reusable for 20 weld joints.
TILE, VINYL	each	Tiles 12" X 12" or 9" X 9"	45 sq ft carton
WAX			
Water Emulsion	ounce	.128 oz/sq ft	1,000 square feet per gallon.
Paste	ounce	1.8 oz/100 sf	1,000 square feet per 18 ounce can.
Spray	ounce	1.78 oz/100 sf	3,000 square feet - 50% mixture.
WELDING			
Aluminum	pound	.0024 lb/inch	23 rods - 36" long/pound: 2" rod/1" weld.
Arc	pound	.017 lb/inch	12" rods - 10/pound: 2: rod/1" weld.
WELDING ROD	pound	.017 pound/1" of weld	Arc welding rod is sold by pound. There are 10 rods/pound of 6013 _" rod 14" long each. Approximately 12" of rod is usable. It takes 2" of rod to weld 1" of material. Therefore, .1 pound (rod) for 6" of weld = .0167 pounds/inch weld = .017 pounds/1" weld.
WIRE PULLING COMPOUND	gallon	.001 gal/ft .002 gal/ft .004 gal/ft	Small wire = .125 oz/ft = .001 gal/ft. Medium wire = .250 oz/ft = .002 gal/ft. Large wire = .500 oz/ft = .004 gal/ft. Normal purchase by gallon.

APPENDIX D

TRAVEL ZONE MAP DEVELOPMENT

TRAVEL ZONE MAP DEVELOPMENT

Travel Zones represent time allowed for round trips of travel to and from the shop. The time for each Travel Zone is constant; however, depending upon time of day, traffic patterns, and signal lights, the distance a craftsperson travels to any particular zone may vary from installation to installation. Therefore, each installation must have its own Travel Zone Map.

Because travel patterns change over time as new roads are cut, old roads are redirected, new buildings are added, and density of traffic changes, Travel Zone Maps should be validated once every two years and updated as required to be kept current.

Travel Zone Map development and validation are not complex processes. They can easily be done by Engineering Technicians and Planner/Estimators using a standard set of steps designed for accurate Travel Zone Map development. A Travel Zone Map Development Team usually consists of two people: a driver who is familiar with the installation and the routes generally used by craftspersons and a timer who takes and records travel time readings.

Travel Zone Map development consists of five basic steps:

STEP #1: GATHER MATERIAL.

Prior to setting out to determine the Travel Zones at an installation, the Travel Zone Map Development Team needs to gather equipment and items needed for data collection. Also arrangements in preparation for travel time data collection should be made.

a) Installation Map. Obtain the best possible installation maps which show streets and buildings. At least one map should show the entire installation and any remote sites. For large installations, several larger scale maps or inserts may be required to show details of high density areas.

b) Data Collection Worksheets. Obtain copies of Travel Zone Map Data Collection Worksheets or develop one for use during data collection. Figure D-1 shows the Data Collection Worksheet used for map development.

c) Authorizations. Obtain any necessary authorizations to access all areas where craftspersons are required to perform maintenance and repair work.

d) Stopwatch and Tools. Obtain a lapse time stopwatch, clipboard, pencils, erasers, and calculator. As a minimum, a digital watch reading seconds is required for taking time readings.

e) Vehicle. Determine what constitutes a typical maintenance vehicle and then locate one for use during the travel time data collection. (At most installations, any car or light truck will do.) Be sure that it has a properly working and calibrated speedometer.

STEP #2: BECOME FAMILIAR WITH THE INSTALLATION.

a) Tour the Installation. Prior to starting data collection

- Review the installation maps
- Tour the installation
- Observe traffic conditions
- Develop lists of questions and observations about installation travel conditions that can be discussed with shop personnel

TRAVEL ZONE MAP DATA DEVELOPMENT WORKSHEET		PAGE OF
SHOP COMPLEX:	INSTALLATION:	DATE:
ROUTE:	MAP NUMBER:	VEHICLE:
TIMER:		DRIVER:
REMARKS:		

POINT (a)	OBSERVATION LOCATION DESCRIPTION (b)	CLOCK TIME (secs.) (c)	ROUND TRIP TIME (secs.) (d)	DEC.EQUIV. TIME (0.0000 hrs.) (e)	EPS CONSTANT (.2238 hrs.) (f)	TRAVEL ZONE # (g)

Figure D-1. Travel Zone Map Data Collection Worksheet

b) Conduct Interviews. Conduct informal interviews with the following personnel:

- Maintenance supervisors
- Inspectors
- Planner/Estimators
- Craftspersons familiar with travel conditions

Notes of traffic condition discussions and other variables that affect travel should be maintained. The interviews and observations will help the team accomplish the following:

- Determine key work sites and normal travel routes
- Identify vehicle parking at various sites
- Identify entry and exit routes to and from the shop areas
- Identify normal traffic patterns and traffic flow
- Locate secure areas

This data enables the team to select a Travel Zone take-off point from which most maintenance crews depart and return and identify the major routes used and not used.

c) Identify Remote Site Locations and Unusual Travel Conditions. Determine if any remote site locations or unusual travel conditions exist so that travel time to each one can be identified and measured.

d) Identify Special Travel Conditions and Travel Hindrances. Special travel conditions and travel hindrances must be identified so that these conditions can be observed. Discussion of these special conditions and hindrances can be found at the conclusion of this appendix.

STEP #3: DATA COLLECTION.

a) Vehicle Speed. Drive 5 miles per hour below the posted speed limit.

b) Routes. Drive the typical routes from the shop areas identified during the interview process and to remote sites.

c) Record Travel Locations. Indicate Travel Zone Map reading point locations at intersections or building locations. Record these on the map as shown in Figure D-2. Also record them on the Data Collection and Analysis Worksheet as shown in Columns (a) and (b) of Figure D-3.

d) Record Time. Record clock time in seconds from the shop to each location on the Data Collection and Analysis Worksheet as shown in Column (c) of Figure D-3.

STEP #4: DATA ANALYSIS

a) Determine the Round Trip Travel Time. Round trip travel to any location may be determined by timing a return trip and adding it to the outbound trip for the same location. Round trip travel time may also be determined by multiplying the Clock Time (Column (c)) x 2 and recording the time in Round Trip Time (Column (d)) on the Data Collection and Analysis Worksheet. See Figure D-3.

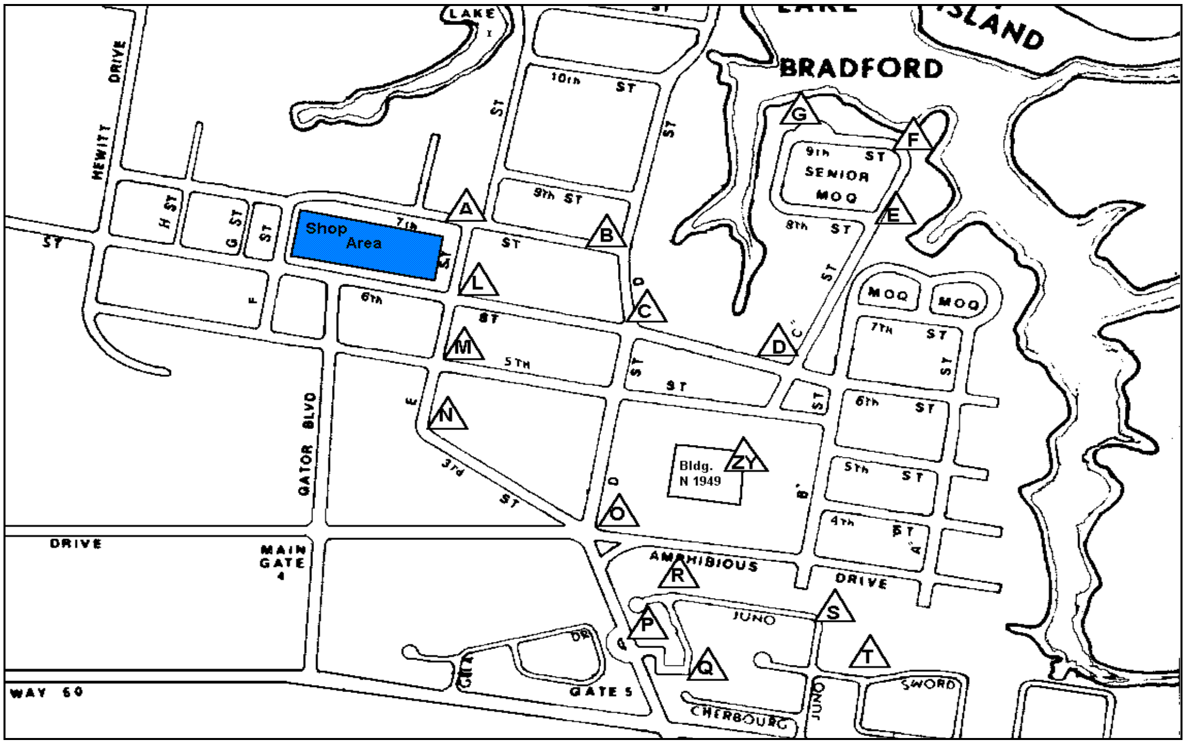


Figure D-2. Travel Zone Map Reading Points

b) Convert Round Trip Time to a Decimal Equivalent (Hours). Divide the Round Trip Time from Column (d) by 3600 and carry to four decimal places. Place the time value in Column (e).

c) EPS Round Trip Time. Add .2238 hours to the Round Trip Time in Column (d) and record in EPS Round Trip Time in Column (f). See Figure D-3. The constant provides for:

- Waiting a short time (less than 6 min) for a vehicle
- Loading a hand carried toolbox into the vehicle
- Walking from the vehicle to the job site
- Opening and closing building doors
- Climbing a stair flight or waiting for and riding an elevator
- Reversing the above activities

When the constant is added, the total EPS round trip travel time to the point is established.

d) Determine the Travel Zone Number. Using the Travel Zone Table shown in Figure D-4, identify the travel zone for each point and record in Column (g) of the Data Development Worksheet. See Figure D-3. This is done by comparing each time in Column (f) with the upper and lower limits shown in Figure D-4 for each zone.

e) Plot the EPS Round Trip Time. Plot the EPS Round Trip Time points from Column (f) on a clean copy of the installation map used to record the travel points. See Figure D-5.

POINT (a)	OBSERVATION LOCATION DESCRIPTION (b)	CLOCK TIME (secs.) (c)	ROUND TRIP TIME (secs.) (d)	DEC.EQUIV. TIME (0.0000 hrs.) (e)	EPS CONSTANT (.2238 hrs.) (f)	TRAVEL ZONE # (g)
A	*Exit shop to E St.*	*15*	*30*	*.0083*	*.2321*	*2*
B	*7th & D*	*46*	*92*	*.0256*	*.2494*	*2*
C	*6th & D*	*73*	*146*	*.0406*	*.2644*	*2*
D	*7th & C*	*92*	*184*	*.0511*	*.2749*	*2*
E	*8th & C*	*200*	*400*	*.1111*	*.3349*	*3*
F	*9th & C*	*261*	*522*	*.1450*	*.3688*	*3*
G	*9th at end*	*300*	*600*	*.1667*	*.3905*	*3*
L	*6th & E*	*A+25*	*40*	*.0111*	*.2349*	*2*
M	*5th &E*	*A+70*	*85*	*.0236*	*.2474*	*2*
N	*E at bend*	*A+109*	*124*	*.0344*	*.2582*	*2*
O	*E at Phib Drive*	*A+143*	*158*	*.0439*	*.2677*	*2*
P	*Gate 5*	*A+194*	*209*	*.0572*	*.2810*	*2*
Q	*Chesbourgh*	*A+235*	*250*	*.0694*	*.2932*	*2*
R	*Ches + Juno*	*A+254*	*269*	*.0747*	*.2985*	*2*
S	*Juno at bend*	*A+281*	*296*	*.0822*	*.3060*	*3*
T	*Juno at Sword*	*A+299*	*314*	*.0872*	*.3110*	*3*
ZY	*Building N194 9 minute wait.*	*A+221+ 540*	*1472*	*.4089*	*.6327*	*6*

Figure D-3. Data Collection and Analysis Worksheet

f) Determine and Draw Travel Zone Boundaries. Draw the Travel Zone boundary lines on the map using the EPS Travel Zone Boundaries in Figure D-4 to aid in determining where the Travel Zone boundaries are on the installation. (See Figure D-5.)

In order to locate and draw the exact zone boundary lines, a method of interpolation must be employed. Here is how it works:

Figure D-4 shows the Travel Zone 2 boundary (Upper Time Limit) as .30 hours. The Data Collection Worksheet (Figure D-3) indicates that this zone limit (boundary line) for Zone 2 changes between Point D (.2749 hours) and Point E (.3349 hours). Since the difference between the boundary line and Point E (.3000 - .2749 = .0251 hours) is less than the difference between the boundary line and Point E (.3349 - .3000 = .0349 hours), the zone boundary line would be

TRAVEL ZONE BOUNDARIES ROUND TRIP TIMES			
ZONE NUMBER	ZONE ALLOWED TIME (HRS)	TRAVEL ZONE LOWER LIMIT (HRS)	TRAVEL ZONE UPPER LIMIT (HRS)
0 (SHOP)	0.00	0.00	0.00
1 (WALK)	0.16	0.00	0.20
2	0.25	0.21	0.30
3	0.35	0.31	0.40
4	0.45	0.41	0.50
5	0.55	0.51	0.60
6	0.65	0.61	0.70
7	0.75	0.71	0.80
8	0.85	0.81	0.90
9	1.0	0.91	1.10
10	1.2	1.11	1.30
11	1.4	1.31	1.50
12	1.6	1.51	1.70
13	1.8	1.71	1.9
14	2.0	1.91	2.10
15	2.2	2.11	2.30
16	2.4	2.31	2.50

Figure D-4. Travel Zone Boundaries

closer to Point D than to Point E. The line can be approximated at a location 4/10 (.0251/(.3349 -.2749) $\cong$ 40%) of the way from Point D to Point E. See Figure D-6.

Each change in Zones must be examined in the same way. Zone boundaries are placed on the map as follows:

- Connect the boundary points for each Zone with a penciled line
- Review time data and boundaries for accuracy and reliability
- Determine the need for and collect any required additional data that will serve to verify boundaries that appear to be unusual or incongruous
- Make minor adjustments to reroute boundary lines as required
- Indicate sites not on the map by writing the location and Travel Zone time on the map

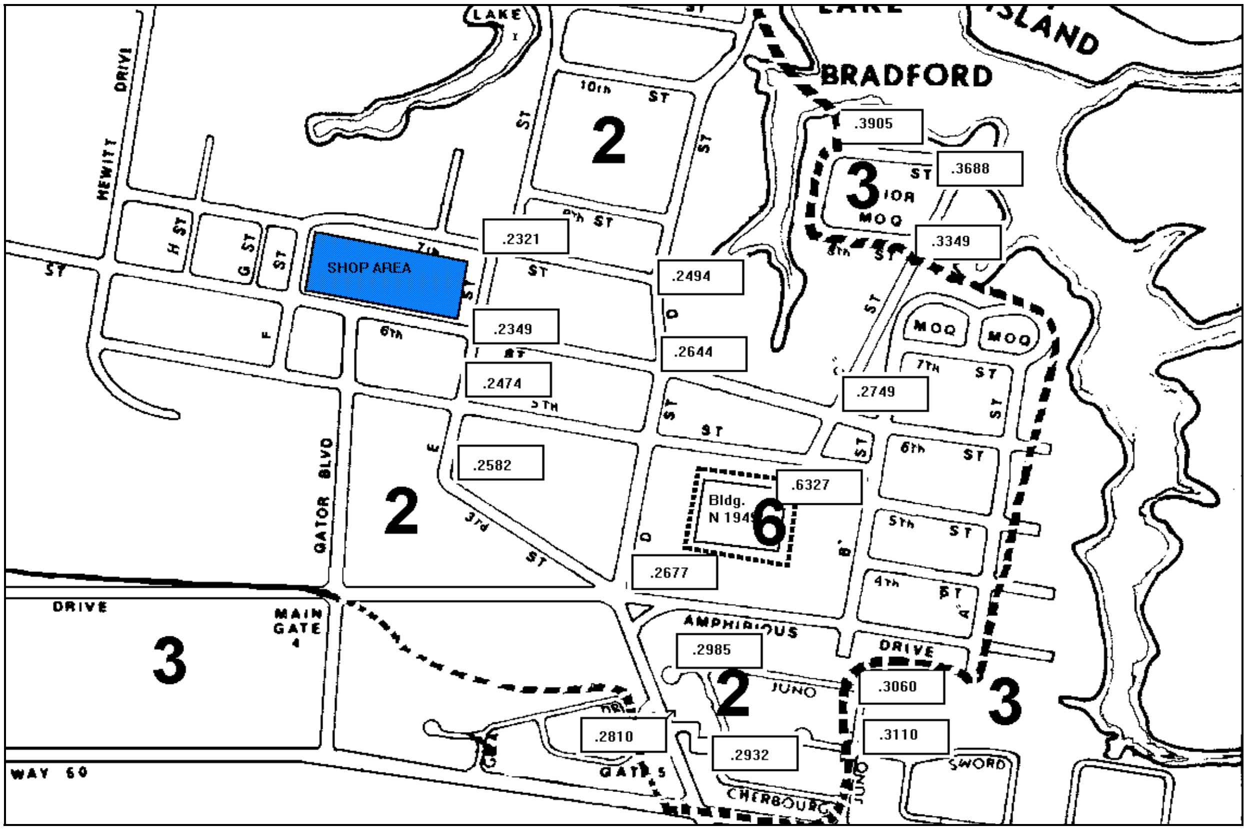


Figure D-5. EPS Travel Zone Map Development

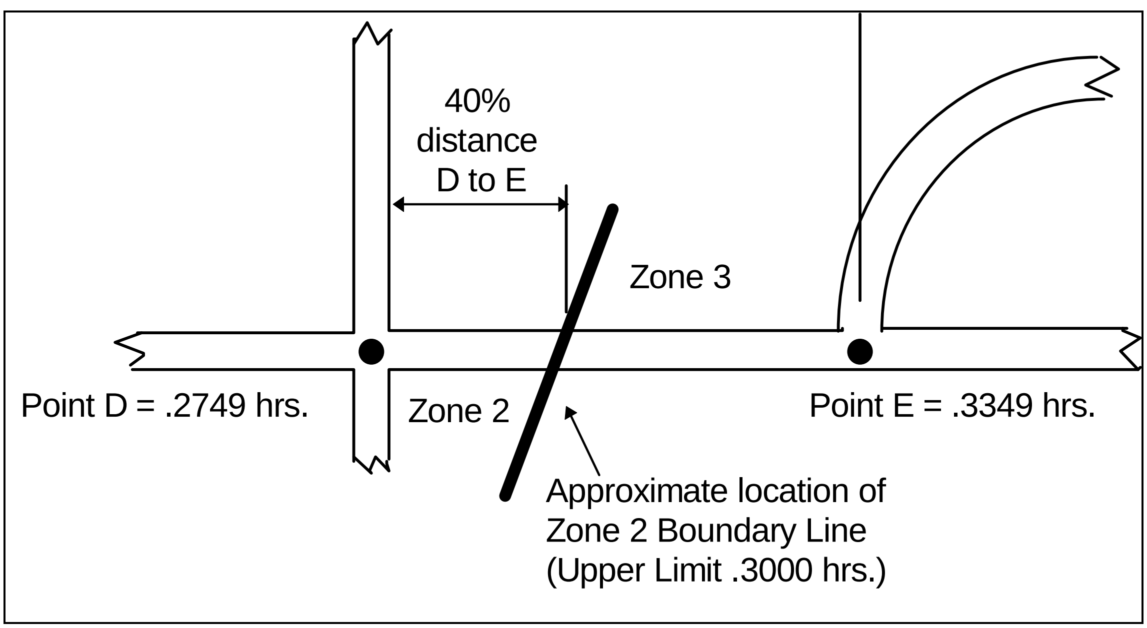


Figure D-6. Travel Zone Boundary Interpolation

STEP #5: PREPARE THE FINAL TRAVEL ZONE MAP.

a) Draw the Travel Zone Boundary Lines. Draw the boundary lines on a clean installation map and number the Travel Zones between the appropriate boundary
When drawing the Travel Zone Boundaries:

- Make minor adjustments to place boundary lines in time averaged locations or along logical, easy to identify paths like streets, property borders, bodies of water etc.
- Avoid over complicated boundaries that may not reflect true travel times. Avoid geometric designs, rectangles, bull's eyes, map grid patterns or configurations that will be hard to read and use
- Avoid boundary lines that straddle buildings. Lines that bisect buildings when they are first drawn should be rerouted to show the entire building in the predominant zone
- Determine if building complexes should be split between Zones. Groups of buildings in a complex may be split between zones, as determined by the study
- Show zone-in-zone facilities. Some zones may have facilities that are a zone within a zone as a result of security requirements, key requirements, etc.
- Show zone boundaries (outlined, shaded or color coded, facilities (outlines, numbers, and names), streets, lists, legends, notes, inserts showing outlying areas, and any additional details required for clarity on the map.

b) Reproduce Copies. Have copies of the map developed and distributed. Wall maps should be on high quality, fade resistant paper, framed and covered with glare free protective material. A CAD Travel Zone Map is easy to both revise and reproduce. Also have small reproductions made for desk top use.

SPECIAL TRAVEL ZONE MAP SITUATIONS:

- **SECURITY AREAS.** Some buildings have security procedures which the craftsperson must follow in order to gain access. These procedures require additional time. Some may be simple such as signing in and out, getting entry approval, waiting for escorts, or locating needed keys. Others may be very time consuming such as having the vehicle searched.

- **INTERMITTENT TRAFFIC HINDRANCES.** Intermittent traffic hindrances occur on a sporadic basis and include bridge lifts, railroad crossings, aircraft runways and approaches, rush hour traffic, daily speed limit changes such as for school zones and military maneuver zones etc. Some research into these situations is required before setting out to determine the time they take. For example, bridge lifts may occur at planned times or at unannounced times throughout the workday. Data should be obtained from bridge representatives regarding the number of bridge lifts that occur each day and the times when they generally occur. The team should plan when observations are required at various times of the day and on different days when the bridge will be lifted so that stop watch readings can be taken to determine the average traffic delay time.
- **TEMPORARY TRAFFIC CONDITIONS.** Temporary traffic conditions are situations that are scheduled to last more than six months but less than a year. When a situation such as a road closure while new storm water drains are installed or a bridge repair is

known, the Travel Zone Map may be altered on a temporary basis. A temporary Travel Zone Map or a partial map for the affected area should be developed along with explanations of the temporary time adjustments. Short term conditions such as construction or repair work that causes slow downs or detours should not be reflected on Travel Zone Maps.

- **SPECIAL TRAVEL SITUATIONS.** Special travel situations must also be identified and incorporated in the Travel Zone Map. These include:

  - **Walking Zone:** Travel Zone 1 provides time for a craftsman to walk from the shop area to buildings in the immediate shop area (approximately .16 hours per round trip from the shop (2500 ft.)). No vehicle or constant time is included.
  - **Alternative Vehicle Travel Zone Maps:** Some craftspersons may routinely use alternative vehicles such as bicycles or motor scooters. Because these vehicles travel at a slower speed than a typical maintenance vehicle, an alternative Travel Zone Map can be developed for areas in which these vehicles are routinely used. For example, Travel Zone 3 using a maintenance vehicle may be Travel Zone 5 when a bicycle is used.
  - **Remote Shop Locations:** Remote craft shops that are assigned to specific areas such as housing, hospital maintenance, and barracks maintenance may need their own Travel Zone Map.

APPENDIX E

SERVICE WORK

SERVICE WORK

A. SERVICE WORK

> **SERVICE REQUIREMENTS**
>
> - ***Not too complex***
> - ***Involve limited amounts of materials***
> - ***Generally involve only one craft or trade in their accomplishment***
> - ***Normally not planned and estimated by Planner/ Estimators***

Service Work consists of requests for minor maintenance and repair requirements that arise in the course of facilities operations. The exact definition of service work varies from installation to installation based on specific dollar or labor hour thresholds. However, at any installation, service work requirements are the most visible work performed by the maintenance shops with the highest level of customer interest in getting the work requirement accomplished quickly and effectively. Because service work

- is reactive in nature
- is not easily and clearly definable
- has an unpredictable demand
- can be located anywhere on the installation

it is often the most costly and least productive work performed by the maintenance shops.

Service work estimates are generally made by the service work receptionist who receives customer requests. Based on the customer's description of the problem the clerk defines the problem on the service request, identifies the location of the problem and assigns a service standard time.

B. ENGINEERED PERFORMANCE STANDARDS

Engineered Performance Standards (EPS) Service data is one source which can help guide Work Receptionists/Dispatchers and Service Order Technicians to ask the customer meaningful questions about the problem or repair requirement and assist them in applying EPS service standards. Service work estimates provide the Work Control function with an estimate of the shop's service work backlog and give the shop foremen an idea of the magnitude of work being assigned.

EPS service work standards, developed from EPS formula data, represent Total Job Phase times. These times include all working time and EPS allowances, such as travel time, job preparation time, and craft delay. In cases where more than one craftsperson is required to perform a given task, additional craft time and allowances have been added as appropriate.

The standard times were developed assuming normal working conditions in terms of weather, accessibility to the job site, etc. Unusual conditions affecting any given job will usually result in a variance in a craftsperson's performance compared to the EPS Service work standard for that job.

EPS service work standards are listed in tenths of an hour (.1 hour equals 6 minutes) and are based on the craftsperson completing an average of <u>three</u> Service calls per trip from the shop area. Two standard times are shown with each task description; a time for work in Travel Zones 1 through 4, and time for work in Travel Zones 5 through 9. In cases where Service work must be done beyond the limit of Travel Zone 9, additional time should be added to the larger standard time (for Travel Zone 5 through 9) as follows:

ADDITIONAL ALLOWANCE (HOURS)

Travel Zone	One Person Jobs	Two Person Jobs
10	.4	.8
11	.6	1.2
12	.8	1.6
13	1.0	2.0
14	1.2	2.4
15	1.4	2.8
16	1.6	3.2

C. APPLICATION

Application consists of writing a Service Work Request from the information received about the job, looking up the proper standard time in the Service work data, and noting it on the form. If the exact task description is not available, and there is no comparable task listed, a non-EPS estimate can be used, with a proper notation (Non-EPS) on the form.

Service work reception should be performed by knowledgeable, skilled, and experienced persons. Persons familiar with the problems being described can generally ask the caller specific questions that better define the problem and assist in describing the work. On occasion, the caller, if properly directed, can even locate and fix some problems on their own without dispatching a mechanic.

TYPICAL SERVICE WORK RECEPTIONIST DUTIES

- ***Receiving and screening emergency work and repair requests***
- ***Identifying self-help requirements***
- ***Advising callers of self-repair methods or alternatives***
- ***Preparing Service Work Requests defining the work and materials***
- ***Assigning cost codes and standard times***
- ***Assigning priorities (Emergency, Urgent, Routine)***
- ***Operating radio dispatch and control system for mobile crews***
- ***Providing advice to customers when problems arise***
- ***Following up with customers and providing status reports***
- ***Maintaining files and reports during and after work performance***
- ***Training others to perform Service work reception duties***

1. Typical Questions.

To determine which Service work standard is the most appropriate to apply, the Service Work Receptionist should ask the customer questions that will help identify the problem, determine the location of the work, and assess the urgency of the response required. Figure E-1 provides a list of the typical questions in the major service work craft areas that can be asked of callers requesting service work. The list is not all inclusive. A Service Work Receptionist may need to ask some, all, or none of the questions based on the information provided by the customer, or ask other relevant questions not listed depending on the problem being described.

TYPICAL SERVICE WORK RECEPTIONIST QUESTIONS

Miscellaneous

1. General
   - (a) Caller's name and telephone number?
   - (b) Building number? Housing?
   - (c) Location of problem - room number; floor; corner of building (SE, SS, etc.)
   - (d) Times someone will be present so work can be accomplished?
2. Heat/air
   - (a) Have you checked circuit breaker?
   - (b) How much difference is there between the temperature you have set and the temperature in the room?
   - (c) Is the switch on the thermostat turned to “on” (“A/C” or “HEAT”, seasonal)?
   - (d) Is thermostat combination heat/AC type? If so, have you checked position?
3. Lock cylinder
   - (a) Is the door metal or wood?
   - (b) Is there anything jammed in the key slot, i.e., broken key, match stem, etc.?
4. Tree trimming
   - (a) Is the tree limb rubbing against the building, power line, phone line?
   - (b) Is the tree limb obstructing traffic or in the way of someone walking on the sidewalk?
   - (c) Approximate length and diameter of branch(es)?
5. Spraying insecticide
   - (a) What type of insect/pest is causing the problem?
   - (b) Where is the problem? In the house, outside, lawn, shrubbery, etc.?

Carpentry

1. Doors
   - (a) Is the door wood or metal?
   - (b) Is the door off its hinges?
   - (c) Is there a hole in the door? How large?

Figure E-1. Typical Service Work Reception Questions

(d) Is the knob loose, or completely missing?
(e) Is the door lock broken/missing?

2. Locks
    (a) Is this change due to personnel changes or a malfunction?
    (b) What is the lock on? Safe? File cabinet? Office? Vault?
    (c) Are Confidential or Secret documents involved?
3. Roof leaks
    (a) What type roof to you have: metal, shingle, slate? Built-up or flat?
    (b) Do you know where the leak is coming from or do you just have a wet ceiling?
    (c) In which room or area is the leak?

Electric

1. Circuit breaker
    (a) Have you tried to reset the circuit breaker?
    (b) What is on the breaker that is tripped? Stove? A/C? Refrigerator?
    (c) Residential or industrial/commercial type?
2. Fluorescent light fixture
    (a) Do the bulbs come back on after they have been off for a while?
    (b) Does the light come on at all?
3. Incandescent light fixture
    (a) Is there a bulb or bulb base in the fixture?
    (b) Is the globe broken?
4. Outlet/wall receptacle
    (a) Broken or no current?
    (b) Have you checked the circuit breaker?
    (c) Is the outlet two prong or three prong?
5. Switch
    (a) Does more than one switch control the object in question? (e.e., three-way switch)
    (b) If lamp, have you checked light bulb?
    (c) Check circuit breaker?
    (d) Broken or no current?

Kitchen Equipment

1. Garbage disposal
    (a) Is anything jammed in the disposal?
    (b) Have you checked the circuit breaker?
    (c) When did you last use the disposal?
    (d) Did you try the reset button?
    (e) Manufacturer and model number?
2. Oven
    (a) Gas or electric?
    (b) Are all heating elements inoperative? have you checked circuit breaker?
    (c) Which elements do not work

Figure E-1. Typical Service Work Reception Questions (Cont.)

(d) Gas- smell gas?
(e) Manufacturer and model number?

3. Refrigerator
   (a) Is the unit cooling at all?
   (b) Is the door closing tight?
   (c) Have you checked the circuit breaker
   (d) Manufacturer and model number?

Plumbing

1. Faucet/spigot
   (a) Have you replaced the faucet washer?
   (b) Is there a leak under the basin from the faucet?
2. Bathtub, shower, sink
   (a) Is the tub/shower/sink draining at all?
   (b) Are other drains draining slowly or stopped up?
   (c) Have you tried a plunger? Drano? Liquid Plumber?
   (d) Is the leak near the drain or faucets?
   (e) Can you tell where the leak is coming from?
3. Toilet/urinal
   (a) Does the toilet/urinal flush at all?
   (b) Does it flush long enough to empty?
   (c) Did you try jiggling the handle?
   (d) Does the toilet have a tank on the back?
   (e) Did you try taking the lid off the tank, reaching inside and closing the flapper valve by hand?
   (f) Did you look inside to see if there was water in the tank?
   (g) Did you check to see if the chain connecting the handle and flapper valve was in place?
   (h) Is water dripping from the tank?
   (i) Is toilet loose on floor or tight?
   (j) Toilet base or bolts broken?
   (k) Is the toilet/urinal draining at all, or did the bowl fill and stay full?
   (l) Have you tried using a plunger to free the clog?
4. Water Heater
   (a) Is water heater gas or electric?
   (b) Have you checked circuit breaker?
   (c) Does water get warm but not hot?
   (d) Leaking?
   (e) Manufacturer and model number?
5. Leaks
   (a) Where is the leak? (kitchen, bath, laundry room, under the house, outside, etc.)
   (b) Is the leak dripping or is it a rapid flow of water?
   (c) Is the leak at a joint or in the middle of a section of pipe?
6. Trap
   (a) Leaking or broken?
   (b) Is there a garbage disposal?

Figure E-1. Typical Service Work Reception Questions (Cont.)

2. High Usage Service Order Time Standards.

A survey of 173,500 service calls spanning three years at six DOD installations showed the breakdown by trade in Figure E-2.

TRADE	PERCENTAGE
Pipefitting, Plumbing	26
Electric, Electronic	23
Heating, Cooling, Ventilating	20
Carpentry	14
Machine Shop, Machine Repairs	6
Roads, Grounds, Pest Control & Refuse Collection	5
Sheetmetal, Structural Iron & Welding	3
Paint	2
Wharfbuilding	1

Figure E-2. Service Call Distribution

Fifty (50) of the most used Service work time standards are listed together for easy reference in Figure E-3.

WORK CODE	DESCRIPTION	TIME FOR ZONES 1-4	5-9
CARPENTRY			
1135	Door - repair wood personnel door	.7	.8
1086	Door, closer - repair closer on wooden door	.5	.7
1112	Door, knob - repair	.6	.7
1233	Roof leak - repair small leak by applying approximately 10 LF of tar	1.2	1.3
1225	Roofing, built-up - repair 100 SF of roofing over concrete deck	5.5	5.6
1289	Window - free double hung window	1.0	1.2
ELECTRICAL			
1522	Circuit Breaker - repairs to circuit	1.0	1.1
1588	Electrical checks - restore electricity	1.1	1.3
1709	Kitchen equipment, disposal - electrical repair	1.5	1.6
1632	Light fixture, floodlight - relamp 1-2 mounted on building or pole, using bucket (2 persons)	.8	1.0
1626	Light fixture, fluorescent - relamp 1-3 glass diffused fixtures, using ladder. Return old tubes	.6	.7

Figure E-3. High Usage Service Work Standards

WORK CODE	DESCRIPTION	TIME FOR ZONES 1-4	5-9
	CARPENTRY (Cont.)		
1628	Light fixture, fluorescent - relamp 11-15 glass diffused fixtures, using ladder. Return old tubes	1.1	1.3
1616	Light fixture, fluorescent - repair	1.6	1.8
1629	Light fixture, incandescent - relamp 1-3, enclosed frosted globe fixtures, to 300 watts, using ladder	.5	.7
1621	Light fixtures, incandescent - repair	.6	.7
1721	Oven - electrical repair	.7	.8
1715	Receptacle - repair	.7	.9
1790	Switch - repair	.6	.7
	ROADS AND GROUNDS		
5522	Pest Control - spraying, per room (100 LF)	.5	.7
5520	Trees - trim 1-6 trees	3.8	4.2
	HEATING, COOLING, VENTILATING		
2016	Air conditioning central unit - check/repair thermostat	.8	1.0
2005	Air conditioning central unit - recharge/repair	3.0	3.1
2006	Air conditioning central unit - service and start	5.6	5.8
2004	Air conditioning central unit - water leak repair	2.2	2.3
2003	Air conditioning industrial unit - clean and set	4.1	4.3
2042	Air conditioning package unit - service and start	4.5	4.7
2128	Refrigerator, walk-in - repair	3.5	3.6
2181	Water Heater - check no hot water	1.9	2.0
	MACHINE REPAIR		
3085	Door, metal - repair lock	.8	1.0
3065	Locksmith - change combination of lock in safe	.8	.9
3100	Locksmith - fabricate duplicate key	.6	.8

Figure E-3. High Usage Service Work Standards (Cont.)

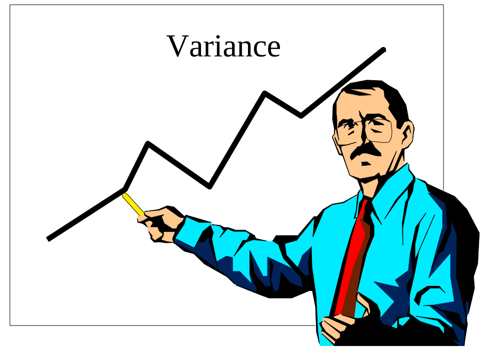
WORK CODE	DESCRIPTION	TIME FOR ZONES	
		1-4	5-9
	PLUMBING		
5022	Commode - repair flush valve and ball cock	1.1	1.3
5023	Commode - repair; running continuously	1.0	1.1
5024	Commode - replace tank parts - will not flush	1.6	1.7
5025	Commode - reset toilet at base	1.7	1.9
5027	Commode - unstop	.5	.6
5054	Drain, floor - unclog drain	.6	.8
5051	Drain, main - unclog drain (with auger)	.9	1.1
5056	Drain, sink - unclog drain	1.0	1.2
5060	Drain, shower, sink or tub drain - unstop	.7	.8
5074	Faucet - repair leak, faucet or hose bibb	.6	.8
5127	Leak - plug small leak in water supply line (quick fix)	.7	.8
5077	Pipe fitting - replace 2" to 4" fitting	1.2	1.4
5163	Sink - repair or replace trap	.7	.8
5015	Tub/shower - repair tub or shower leak	1.1	1.3
5014	Tub/shower - unplug	.7	.9
5004	Washbasin, faucet - repair/replace	.7	.8
5224	Water line - permanent repair of leaking supply line by replacing section of pipe	1.4	1.6
5225	Water line- repair leak in threaded pipe joint	2.2	2.4
5223	Water line - temporary repair of leaking supply line with pipe sleeve	.7	.9

Figure E-3. High Usage Service Work Standards (Cont.)

APPENDIX F

VARIANCE ANALYSIS

VARIANCE ANALYSIS



Variance analysis is the logical evaluation of the reasons for discrepancies between estimated labor hours and actual performance labor hours. Variance analysis should be conducted by maintenance managers to identify and reduce or eliminate system and shop inefficiencies. Labor hour variances often occur for legitimate reasons. Some of the reasons are difficult to identify. Some of the reasons are difficult or impossible to eliminate. Systematic variance analysis aids management to identify causes of unacceptable labor hour variances and solutions to avoidable causes.

Variance analysis meetings should be held on a regularly scheduled basis, and analysis should be conducted on recently completed or in-progress jobs which have exhibited significant deviations between estimated and actual hours for the entire job or a given phase. The meeting should be attended by managers, schedulers, planner/estimators, the planner/estimator supervisor, industrial engineers, shop foremen, and, when appropriate, representatives from system support functions such as supply and transportation. The meeting should not resort to a “finger pointing” session in which blame is directed at an individual or group. Rather, the tone of the meeting should be cooperative and progressive, in which each individual contributes to identify and solve problems for the benefit of the organization.

Since official data may not be available for all jobs at the time a meeting is held, rough figures prepared by individuals involved in the jobs to be analyzed may be adequate. Any information regarding the progress or accomplishment of the jobs to be discussed and possible reasons for labor hour variances should be documented prior to the meeting.

Due to the interrelated nature of the various activities in a real property maintenance organization, a variance analysis investigation looks at problems which have occurred or may potentially occur in each of the maintenance management system components. Some of the problems are shown below.

a. Work Generation.

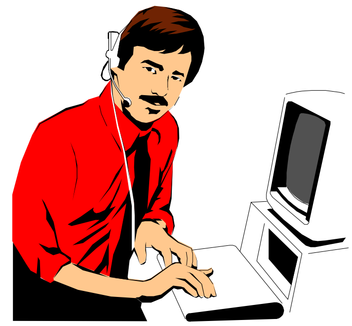
(1) A high percentage of work being identified by the customer versus work identified through facility inspection programs and PMI. Work identified by the customer is often a result of problems or situations which have already occurred, placing the maintenance organization in a reactive mode instead of a proactive mode. Productivity of the entire RPMA generally suffers when operating in a reactive (crisis management) mode.

(2) The customer being indecisive or incomplete in defining the scope of work. It is difficult for P/Es to generate accurate estimates against a “moving target”. Talking with the customer on a site visit during estimate preparation helps to provide the P/E with insight into what the customer wants, but management needs to stress to the customers to accurately define the work desired at the outset to minimize counterproductive job amendments due to changes in job scope.

b. Work Reception.

(1) The work receptionist inadequately defining the work on the work request. The work receptionist needs to systematically prompt the customer for information regarding the required work when entering the work request. A significant advantage may also be gained if the work receptionist has at least minimal knowledge of the various trades.

(2) Work reception duplicating work requests. Multiple requests for the same work is counterproductive for the entire RPMA organization, e.g. shops responding to Work Requests which have already been assigned and completed.



c. Work Approval.

(1) Management not thoroughly reviewing work requests to assess urgency and funding constraints. Work should not be approved which is not in line with current operating directives. Management must also determine if the work should be given a detailed estimate or scoping estimate.

(2) Approving work which exceeds the capability of the in-house work force to perform. The labor hours for some work (PMI program work, for example) may exceed the available manhours the shops have to perform the work. Work should be screened to determine if it should be performed in-house or by contract.

d. Work Planning and Estimating.

(1) Management not reviewing plans and estimates for quality and completeness. Job sketches and bills of materials should always be included where applicable. Task time for additional material handling, additional work locations, and heavy equipment travel time must be included, if applicable, to avoid underestimating the work.

(2) Planner/Estimators not communicating with shop foremen during preparation of estimates. Particularly on larger, more complex jobs, discussing work plans and procedures with shop foremen will likely result in a more accurate and thorough estimate.

e. Material Coordination.

(1) Work delays caused by supply shortages or by incorrect substitute materials being ordered by supply. If insufficient or incorrect materials are available for the job, the work may have to be aborted as scheduled or after work has commenced. Customer facilities may be in disrepair. Working with insufficient or inadequate materials is highly detrimental to productivity and may significantly affect the accuracy of estimates.

(2) Failure to segregate or stage materials in supply for scheduled Work Requests. Excessive time spent by craftspersons obtaining materials is charged to the job. This extra time is not included in the job estimate.

f. Work Scheduling.

(1) Scheduling problems among shops. Well planned estimates are generally phased according to the order crafts should appear on the job site. Schedulers must be cognizant of various craft, man-hour, and skill level requirements of each job to avoid scheduling conflicts and resulting nonproductive hours being charged to jobs.

(2) Scheduler not communicating with shop foremen. Shop foremen must communicate with the scheduler to ensure that previously completed work is removed from the schedule and carryover work is included on the next schedule.

(3) Shop foremen not communicating with other shop foremen. The lead shop foreman on a given job should coordinate with other shop foremen throughout the course of the job to ensure that crafts appear on the job at the proper time and in the proper sequence.

g. Work Accomplishment.

(1) Lack of supervision and quality control. Administrative requirements of shop foremen should not prevent the foremen from visiting job sites on a routine basis during the day. Shop foremen should spend approximately half of their day in the field supervising work and expediting work. Shortfalls in this area may significantly impact productivity and job cost.

(2) Failure to recognize and act on shop inefficiencies. Consistently high variances between estimated and actual work may be due to shop inefficiencies such as lack of journeyman level craftspersons, lack of vehicles, lack of proper training, lack of proper tools and equipment, or personnel related problems. Determining where the deficiencies lie is the first step in taking action towards their resolution.

h. Reporting.

(1) Inaccurate reporting of labor hours. Labor hours charged to jobs must not include hours spent on other jobs or hours which should be charged to overhead functions.

(2) Inaccurate and untimely data entry. Large variances may be the result of erroneously entered data from time cards or failing to promptly enter data for jobs prior to generating variance analysis reports.

Figure F-1 provides a variance analysis checklist which may be used to identify by job phase the underlying reasons for variances between estimated labor hours and actual labor hours. The checklist aids managers in isolating common causes of significant labor hour variances, and serves as a tool in work evaluation meetings to identify trends and develop solutions.

WORK CENTER:	WORK ORDER:	DATE JOB COMPLETED:	
ITEM #	DESCRIPTION (EXPLAIN REASONS)	YES	NO
1.	Was the job scope or estimate changed after the job was started?		
2.	Was the change sent to Planning for a revised estimate?		
3.	Were there any unusual delays during the job?		
4.	Was the job accomplished differently than planned?		
5.	Were materials complete before the job was started?		
6.	Were substitute materials used?		
7.	Was travel time & return to the shop for lunch figured properly?		
8.	Were any of the following encountered & not charged to overhead?		
a.	Maintenance & repair of shop tools and equipment on the job?		
b.	Excessive waits for materials?		
c.	Excessive waiting for transportation/equipment?		
d.	Excessive wait for job assignment?		
e.	Delay due to weather?		
f.	Shop clean-up?		
g.	Inspections?		
h.	Medical?		
i.	Other (explain):		
9.	Was work stopped by Management for any of the following reasons?		
a.	Training Classes?		
b.	Safety meetings?		
c.	Charity or bond campaign?		
d.	Personal problems/counseling?		
e.	Other (explain):		
10.	Were workers pulled from this job for emergency service response?		
11.	Was the labor hour data for this job captured accurately?		
12.	Was labor hour data input properly to the computer?		
13.	Do the JP&E and computer time estimates match?		
14.	Did the Planner visit the job site while planning the job?		
15.	Was the job properly planned using EPS where applicable?		
16.	Was a JP&E Worksheet completed for each phase?		
17.	Were correct EPS references used?		
18.	Was additional material handling time given (if required)?		
19.	Was additional craft time given (if required)?		
20.	Was the job coordinated with the shop supervisor(s)?		
21.	Did the planner & shop supervisor(s) agree on the:		
a.	Number of workers?		
b.	Physical contents of the plan?		
c.	Equipment needed?		
d.	Material requirements?		
22.	Was rework required? (explain):		
23.	Were extra personnel used on the job?		
24.	Were worker trainees used?		
25.	Was worker performance satisfactory?		
26.	Were work methods satisfactory?		
27.	Did workers use excessive personal time?		
28.	Did workers report their correct job start & stop times?		
REVIEW DATE:	REVIEWER:	INDUSTRIAL ENGINEER:	DATE:

Figure F-1. Variance Checklist

APPENDIX G

SENIOR MANAGERS OVERVIEW

SECTION I
INTRODUCTION

For a facilities maintenance management system to operate at maximum effectiveness and efficiency, management positions from the top of the organization through the first-line supervisors must understand how the overall facilities maintenance management system operates and how the components of the system relate to each other. Without this understanding managers may be hampered in their ability to accomplish effective and efficient facilities maintenance.

Where facilities maintenance managers do not understand the facilities maintenance management system in its entirety, tunnel vision seems to take over. The management perspective narrows to the width of the specific function they have been tasked to manage. As a result, decisions made in one functional area may severely impact another functional area not being considered. If these effects go unheeded, inefficiencies will build into the system and ripple throughout the organization. Final result serious effects on productivity and performance quality.

On the other hand, managers who have a good understanding of the facilities maintenance management system are aware of the valuable management tools that exist within the system. Specifically, the work estimating component as an integral part of the system provides facilities maintenance managers throughout the organization with estimates for use in planning, scheduling, work accomplishment, and an important work evaluation processes.

The Senior Managers Overview - Appendix G is designed to provide facilities maintenance managers with useful information to better understand their respective facilities maintenance management functions and the relationship those functions have to work estimating. It will also provide managers with an understanding of the estimating process, the content of the estimate, and the way estimates can be used as a valuable mechanism for managing work and improving productivity.

SECTION II
FACILITIES MAINTENANCE MANAGEMENT

A. OVERVIEW

Effective facilities maintenance management is the efficient control and utilization of Real Property Maintenance Activity (RPMA) resources. Responsibility for facilities maintenance at the installation level ultimately rests with installation/base commanders who rely on competent professional staffs to develop, manage, and execute RPMA operations and maintenance plans. Through the utilization of modern management concepts such as Total Quality Management (TQM), the responsibility for effective maintenance management is shared at all levels within the RPMA organization.

RPMA FACILITIES MAINTENANCE MANAGEMENT SYSTEM OBJECTIVES

- ***Provide proper and consistent levels of maintenance***
- ***Increase work force productivity***
- ***Attain the maximum practical return from resources expended***
- ***Insure standard and efficient methods of work control***
- ***Provide appropriate response to customer requirements***

The importance of effective facilities maintenance management in this era of ever shrinking defense budgets cannot be over emphasized. Well executed facilities maintenance management programs result in:

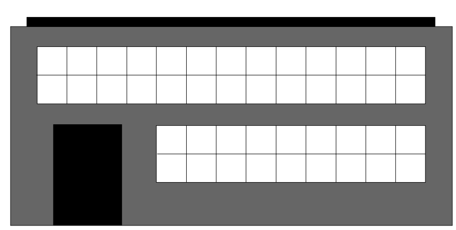
- better control of real property
- increased life span of aging facilities
- improved work force productivity
- enhanced service quality

B. FACILITIES MAINTENANCE MANAGEMENT SYSTEM COMPONENTS

A facilities maintenance management system is comprised of the components shown in Figure G-1:

MAINTENANCE MANAGEMENT SYSTEM

A completely integrated group of components which provides control over facilities maintenance from beginning to end



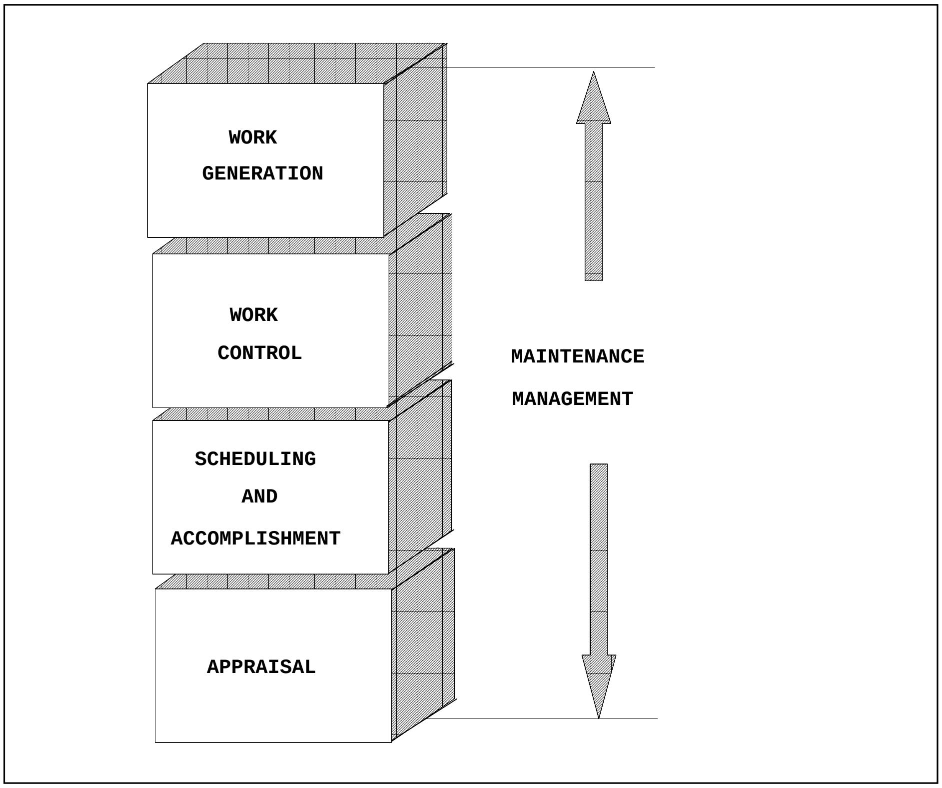


Figure G-1. Facilities Maintenance Management System Components

1. __Work Generation.__
As depicted in Figure G-2, there are several ways work can be generated.

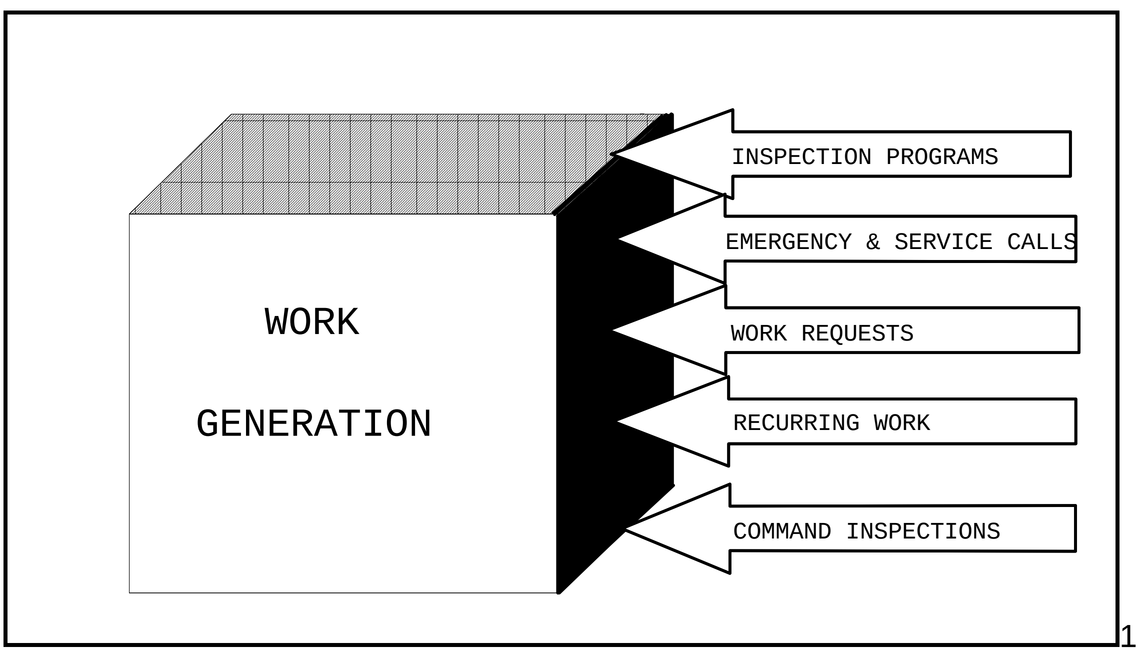


Figure G-2. Work Generation

a. Inspection Programs. Real property condition inspection performed by structural, mechanical, and electrical inspectors can be used in establishing a realistic backlog of work. Inspectors identify deficiencies and provide dollar estimates of the work and materials required to correct them. Condition inspections are the most pro-active type of work generation because they permit maintenance managers to plan for work accomplishment on the basis of severity of requirements and availability of resources.

CONDITION INSPECTIONS

The most pro-active type of work generation

Maintenance and repair work requirements can also be generated by personnel performing Preventive Maintenance Inspections (PMI) and routine operator inspections of equipment and systems in operation. These personnel report repair requirements discovered during the course of performing PMI, operator checks, or system operation. Reported repair requirements can then be estimated and performed based on the severity of the problem and funding constraints. PMI and operator generated work requirements are also pro-active in that the maintenance staff identifies the work and takes action to correct the problem versus experiencing a breakdown or having the customer identify the work requirement.

SERVICE CALLS

The most reactive and costly work performed by the RPMA organization

b. Service Calls. Customer generated requests for minor maintenance and repair requirements are the most reactive and customer visible work performed by the RPMA organization. This work has a high level of customer interest and requires quick response. It may, however, be the most costly work performed by the RPMA organization due to unpredictable demand, undefined work requirements, multiple work locations, and unsuitability for scheduling. Inherent are high levels of indirect productive time associated with travel, material acquisition, job planning, and troubleshooting.

c. Work Requests. Work Requests for work exceeding the minor maintenance and repair parameters of a service call are generated by authorized installation customers. They provide a continuous source of work generation within a facilities maintenance organization. Work Requests have the following characteristics:

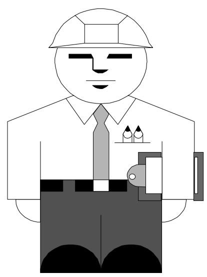
- definable work
- level of effort can be estimated
- predetermined material requirements
- readily planned and programmed for accomplishment
- easily scheduled
- highly productive elements

d. Recurring or Standing Work Requests. Most of this work is estimated on an annual basis and accounts for a significant percentage of a maintenance organization's productive labor hours. Although much of this work may be performed by contract, Planner/ Estimators often develop labor hour estimates to validate contractor bids as well as develop estimates for work performed by in-house resources.

RECURRING WORK

- ***Refuse collection***
- ***Grounds maintenance***
- ***Janitorial services***
- ***Plant operations***
- ***Preventive maintenance of equipment & systems***

e. Command Inspections. Command inspections are inspections which occur on a scheduled or unscheduled basis to determine maintenance, safety, or health deficiencies. In some cases these inspections are the result of regulatory requirements to determine compliance with OSHA, environmental regulations, or the status of special interests such as asbestos, PCB, or lead based paint contamination. These inspections normally result in deficiencies that are tracked with command interest until completion, resolution, or compliance.



2. <u>Work Control.</u>

The work control function, as shown in Figure G-3, enables the large input of work from all work generation sources to be handled efficiently and effectively based on criteria such as cost, urgency, and capability. Work control normally includes the processing and control of all work from the time it is identified until the time it is accomplished (either by the shops or by contract) or canceled.

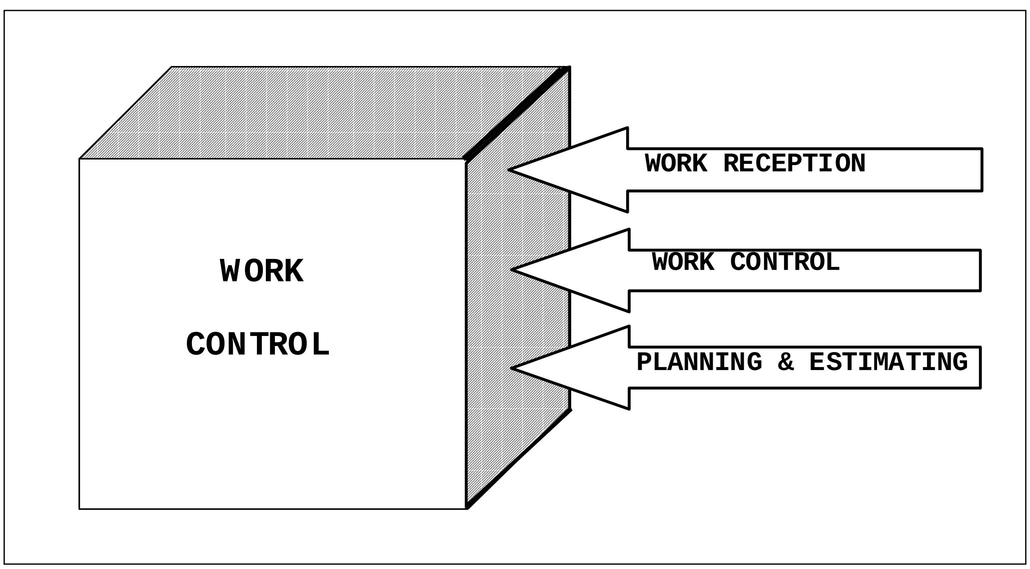


Figure G-3. Work Control

a. Work Reception. Work reception is the point within the work control function where all identified work enters into the facilities maintenance management system. It is the point where:

- initial customer contact is made
- internal work screening and classification occur
- formal work document numbers are assigned
- customer interface for work status updates occur

b. Work Control. After a work requirement has been identified and documented through work reception, the work control function is responsible for screening each Work Request. Work Control determines:

- the type of work and relative urgency of the requirement
- whether a scoping or preliminary estimate is required
- if the funds for the work are available

If the work is approved for accomplishment, shop workload is examined to determine if the requested work should be performed in house or by contract. Work that is approved without available funds is considered unfunded backlog.

c. Planning & Estimating. Approved Work Requests are planned and estimated by Planner/Estimators to determine labor hours, material, equipment, and costs. Preliminary or scoping estimates may be developed to assist in the work screening process. Detailed estimates are developed when the decision is made to proceed with work accomplishment.

WORK ESTIMATING PROCESS
3 MAJOR ACTIVITIES

(1) Determine the work requirement
(2) Plan the work
(3) Estimate labor, material, and equipment requirements

Detailed estimates are the basis for scheduling shop hours and equipment and ordering the materials and parts required to complete the work. They provide the shop foremen with information on which to base work assignments, and serve as the basis for work appraisal when the jobs are complete. Because these estimates are an integral part of the facilities maintenance management system, they should only be done by individuals who have the pertinent technical background and proper training to produce accurate estimates and complete work packages.

3. <u>Work Scheduling and Accomplishment.</u>

Once a detailed estimate has been developed, reviewed, and approved, materials are ordered. As material is received it is staged for in-house work accomplishment. When all the material is in hand, the scheduler is notified that the job is available for scheduling. The scheduling and accomplishment function is depicted in Figure G-4.

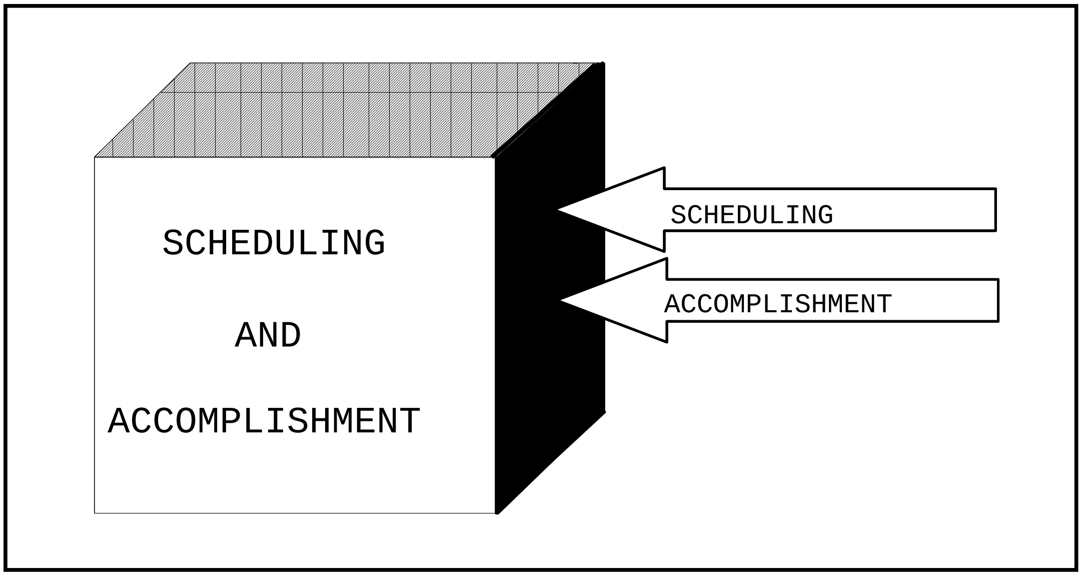


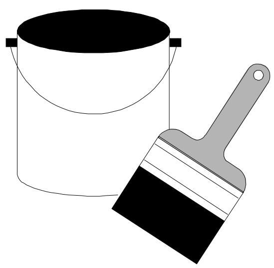
Figure G-4. Work Scheduling and Accomplishment

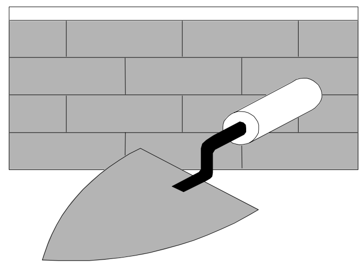
a. Scheduling. Scheduling is the assignment of labor resources to identified work requirements for accomplishment in a defined time frame. The objective of scheduling is to efficiently accomplish work according to the resources available. For in-house work, scheduling is done on a shop by shop basis. This approach insures that the work is ready to be performed when the craftspersons are available. It is important that the necessary equipment be available as planned and materials be staged or available. It is equally important that each assigned shop be ready and available to accomplish their designated job phases in the planned work sequence.

Scheduling occurs at two levels. Initially scheduling is the responsibility of the scheduler. This individual schedules shop hours on a master schedule based on long and short range plans provided by work control. The scheduler develops a weekly schedule which is distributed at shop scheduling meetings where shop foremen discuss the schedule to ensure that all the planned work can be accomplished.

The second level of scheduling is the day to day assignment of work by the shop foreman or shop planner. Each shop foreman is responsible for coordinating with the other shop foremen involved in a job to ensure that the work sequence of a job is maintained. The goal is to avoid long delays between job phases. The shop foreman provides job status and feedback to the scheduler so that the schedule can be updated as work is completed.

b. Accomplishment. Work accomplishment is the responsibility of the shop foreman and the craftspersons in the shop. The shops are responsible for performing work in accordance with the job plan and within acceptable quality levels. Craftspersons are responsible for notifying the shop foreman of changes in job scope discovered after the actual work begins. Shop foremen coordinate scope changes with the Planner/Estimator who estimates approved scope changes and provides the scheduler with hour adjustments. It is important that actual labor hours required to perform the work are captured and reported accurately.





4. **Appraisal.**

To complete the facilities maintenance management system, an appraisal process is used to look at the efficiency and effectiveness of the work being performed (Figure G-5.)

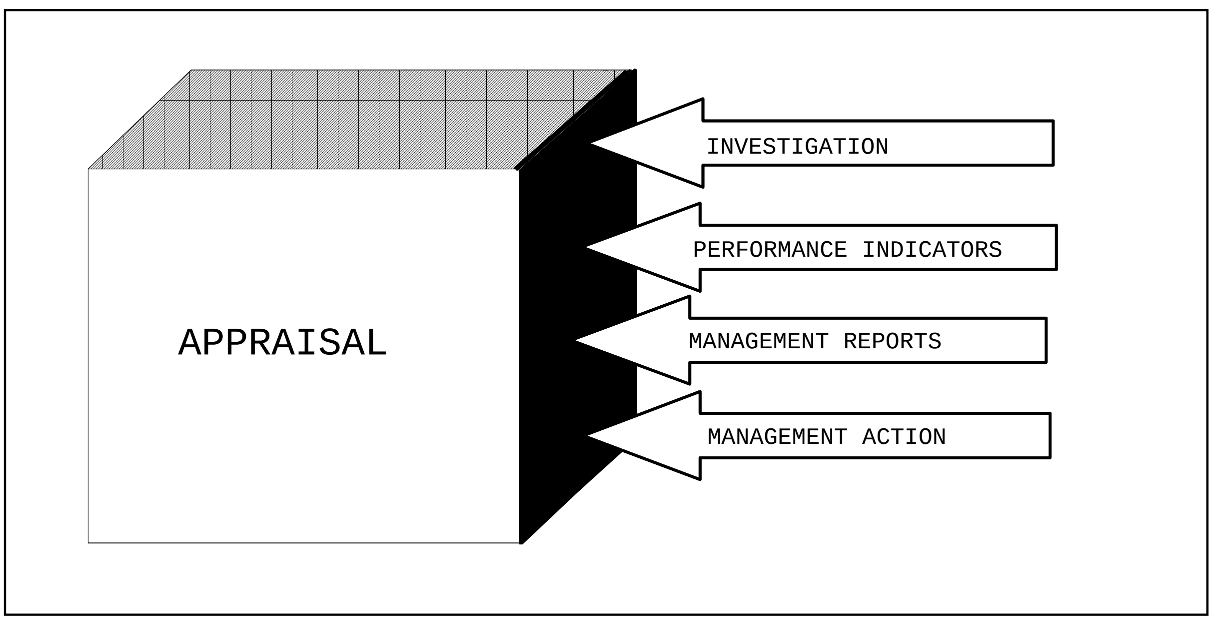


Figure G-5. Appraisal

a. Investigation. Continuous monitoring of reported labor hours should take place during job performance. Unusual data should be swiftly and carefully analyzed and action

taken by foremen and maintenance managers to correct any problems brought to light by the analysis.

3

b. Reports. When the work is completed, job data is compiled into reports showing estimated versus actual labor hours and costs expended. This data is forwarded to management personnel for management action.

WORK APPRAISAL IDENTIFIES:

- ***Transportation problems***
- ***Communication problems***
- ***Material acquisition problems***
- ***Poor work methods***
- ***Resource shortages***
- ***Planning and estimating problems***
- ***Corrective actions to take to eliminate process problems***

c. Management Action. Careful variance analysis aids in determining the root causes of unusual situations occurring during work accomplishment. This analysis should be conducted shortly after work completion to help eliminate or reduce similar problems from occurring on future jobs.

d. Performance Indicators. Performance indicators are a management tool within the work appraisal process. Management reports based on work data provide information for establishing performance indicators. Some of the many useful performance indicators may be used to monitor:

- labor, equipment, and materials expended
- actual versus estimated costs
- actual versus estimated labor hours
- job status
- work accomplishment

Tracked over time, these indicators provide a basis for comparative analysis, data for performance appraisals, and as a basis for decisions regarding whether corrective actions are needed to improve work processes. Analysis can also be conducted to determine whether previously implemented corrective actions are proving effective.

C. FACILITIES MAINTENANCE MANAGEMENT SYSTEM INTEGRATION

SYSTEM COMPONENTS

For a facilities maintenance management system to run smoothly, all of its components must be operating:

- ***Work Generation***
- ***Work Control***
- ***Scheduling and Accomplishment***
- ***Work Appraisal***

As functions of the maintenance management system, the system components are totally integrated. They support each other as well as the system as a whole. For work to be performed efficiently and economically, personnel working in the respective functional areas must work together toward the common goal of keeping a smooth flow of work through the system. Personnel in the facilities maintenance organization should understand their job responsibilities and the effect their work has on other functional areas. Standard operating procedures (SOPs) should be developed and periodically updated to ensure that work moves through the system smoothly and efficiently.

Appraisal results should not be used to place blame on other system components or particular individuals within the organization. Rather, the work appraisal function should serve as a means of identifying work process problems so that continual system improvement can occur. Managers should use the information provided in management reports, performance indicator programs, and system analyses as a basis for making positive corrective changes in the processes supporting the operation and maintenance effort.

SECTION III
WORK ESTIMATING

A. DEFINITION

Work estimating is defined as follows:

WORK ESTIMATING

The process used to determine requirements, plans, and estimates to accomplish a defined amount of work.

The work estimating process is part of the work control function in a facilities maintenance management system. It provides both planning and work accomplishment support within the function. Its dual purpose necessitates two types of work estimates.

B. TYPES OF ESTIMATES

1. <u>Scoping Estimates.</u>

Scoping estimates are preliminary or "ball park" estimates used in the work control screening process to determine if the requested work should be performed. If the work is to be performed, scoping estimates can aid in determining whether the job is accomplished in house or by contract. The estimates are provided to customers who want to upgrade or repair their facilities, but, first, want to know how much the changes will cost before they decide to commit resources to the project. They are also developed to obligate funds prior to development of a complete job package. To meet these various planning purposes there are three types of scoping estimates:

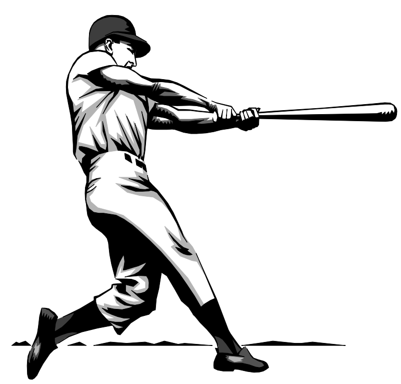
SCOPING ESTIMATE

For planning purposes, provides an approximation of effort and dollars required to perform job.

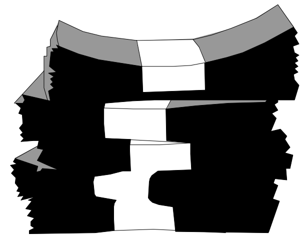
a. Desk Top Estimates. Desk top estimates are, as the name implies, normally developed at the Planner/Estimator's desk. The estimate is based on one of many types of unit price standards estimating methods:

- R.S. Means™ for new construction and maintenance work
- Walkers™ for new construction and alterations
- Facilities Engineering Job Estimating (FEJE) Unit Price Standards (UPS) for maintenance and repair
- Job Order Contracting (JOC) standards for minor alterations and repair work

These estimates are considered to be ± 25% accurate.



b. Funded Estimates. Funded estimates are more accurate than desk top estimates because they are used to obligate resources. For these estimates, the Planner/Estimator usually makes a site visit to determine the work and material requirements and incorporates them into the scope of the estimate. Similar to desk top estimates, unit price standards are used to arrive at the estimated labor and material costs.



c. Inspection Estimates. Inspection estimates are developed by inspectors as a part of a facilities condition inspection program. These estimates facilitate the work control screening process by providing the facilities manager with reliable information for use in determining near term accomplishment or backlog requirements. Deficiencies found and scope of repairs are determined by the inspector. These serve as the basis for developing an inspection estimate and a Work Request document.

2. <u>Detailed Estimates.</u>

Detailed estimates for in-house and contract work are developed to determine the following:

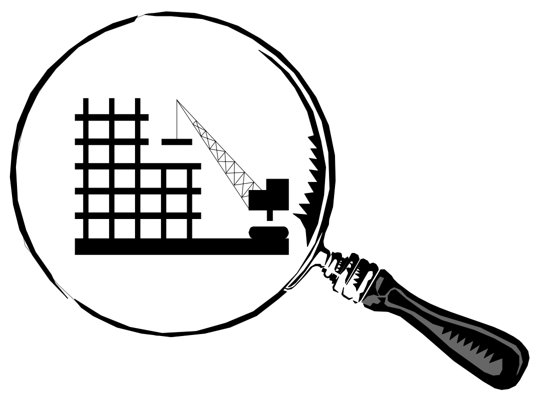
- specific work requirements
- work sequencing
- craft tasks
- labor hours
- specific material and equipment quantities
- total dollars required

Detailed estimates are based on field validation site visits. They contain:

- a detailed sequence of the job phases and craft phases
- detailed descriptions of the work tasks to be performed
- sketches, diagrams, and maps
- detailed bills of material

Detailed estimates for in-house maintenance and repair work require application of standard data to maintain consistency and accuracy.

DETAILED ESTIMATE
Determines labor and material resources and provides detailed information on the requirements to schedule and perform a job.



3. <u>Service Calls.</u> Service calls consists of the minor maintenance and repair requirements that arise in the course of facilities operations. The exact definition of service work varies from installation to installation based on specific dollar or labor hour thresholds. Service requirements are:

- not too complex
- involve limited amounts of materials
- generally involve only one craft or trade in their accomplishment
- normally not planned and estimated by Planner/Estimators

Service call estimates are generally made by the service work receptionist who receives customer requests. Based on the customer's description of the problem, the clerk assigns an estimate from a book of service standards. Service call estimates provide the work control function with an estimate of the shops' service work backlog and give the shop foremen an idea of the magnitude of the work being assigned.

C. PLANNING AND ESTIMATING ACTIVITIES

The work estimating process for both scoping and detailed estimates consists of three principal activities.

WORK ESTIMATING ACTIVITIES

- ***Determine the work requirements***
- ***Developing a work plan***
- ***Estimate the labor and material needed to accomplish a defined amount of work***

1. <u>Determine Requirements.</u>

Identifying all the requirements of a job is essential to developing a good estimate. When the Planner/Estimator receives a Work Request from work control, the customer generated description may not be well defined. Even if a Work Request has been developed by a facility condition inspector or a craftsperson, it may not contain sufficient detail to fully determine all the work requirements. There are four steps to determining the requirements of a job.

STEP #1: READ THE WORK REQUEST

Reading the Work Request sounds simple. However, there is more information on a Work Request than the basic description of work. For instance, the date the request was received in Work Reception is very important:

- older Work Request work descriptions may have changed
- the scope of work can increase or decrease over time
- changes in customer personnel may result in different ideas about the work requirement
- the requirement may no longer exist

The Work Request also contains a Point of Contact and a phone number the Planner/Estimator can call to discuss the work to be performed and arrange for a site visit.

STEP #2: TALK TO THE CUSTOMER

Talk to the customer by phone in conjunction with a desk top estimate and in person at the job site for a funded estimate or detailed estimate. These conversations can prove invaluable for determining the work requirements. By talking to the customer, a clearer description of the work is gained which helps to ensure that the job meets the customer's expectations when it is completed.

STEP #3: VISIT THE JOB SITE

For detailed and funded estimates, a site visit helps to accurately determining the work requirements. This work validation visit allows the Planner/ Estimator to investigate the requirements in terms of the magnitude of the work to be done.

The Planner/Estimator can also obtain a general sense of the surroundings in which the craftspersons will be working. While at the work site, the Planner/ Estimator should:

- look into where materials and tools can be stored
- consider the effects of dust or noise on customer personnel
- determine if power outages are required and inform the customer
- determine access requirements such as escorts and clearances

If possible, arrange to meet the customer's Point of Contact at the job site so that work requirements can be discussed. Throughout the field visit, the Planner/Estimator should take notes to ensure that all the relevant details are gathered during the visit and eliminate the need for additional site visits.

JOB SITE VISIT

- ***Take measurements***
- ***Draw sketches***
- ***Identify material requirements***

STEP #4: COLLECT RELATED SITE INFORMATION

Within the facilities engineering organization, a great deal of information is available to help the Planner/Estimator develop a good work estimate.

- **Facilities Plans** - provide graphic renderings of a facility's structural and mechanical components. The specific area where the work is to be performed can be studied on these drawings to determine measurements and equipment information vital to the work requirements of the job. These drawings can also be copied and portions provided as drawings in the work package to facilitate the craftspersons' understanding of the work requirement.

- **Equipment Manufacturer Data** - helps the Planner/Estimator ensure that the work requirements identified are within the parameters of supporting pieces of equipment or within the manufacturer's specifications.

- **Facility History Files** - contain past work performed giving Planner/Estimators insight into what may be required as a part of the job to be estimated. For recurring work, a review of the previous year's estimate compared to the actual work accomplished should be done.

Having a clear understanding of the work requirements is essential to developing an estimate that accurately defines the amount of work to be done. When the work requirements are not thoroughly researched and identified, the negative effects ripple throughout the work estimating process and subsequently throughout the facilities maintenance management system. Excessive changes in scope are generally the most noticeable results.

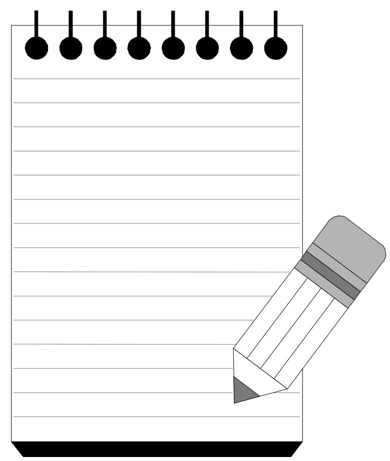
SCOPE CHANGES

- ***Increase costs to the customer***
- ***Result in additional inconvenience and disruption as the job completion time expands beyond what was anticipated***
- ***Cause delays associated with ordering additional materials***
- ***Cause scheduling problems when craftspersons have to work longer than scheduled at a particular work site***

2. <u>Develop a Work Plan.</u>

"Plan your work, then work your plan."

This saying is one of the principles of effective maintenance management. Planner/ Estimators must plan the work so that a clear, concise, estimate is developed. Regardless of whether the end product is a scoping estimate or a detailed estimate, job planning is essential to ensure that the estimate accurately reflects all the work, crafts to be used, equipment required, and materials to be used. After the work requirements have been determined, the Planner/Estimator develops a rough job plan. The following are the detailed steps for developing a rough work plan:



STEP #1: DETERMINE WORK SEQUENCE

Determine craft sequence based on the way in which the shops work.

- **Single Trade Shops** - At many installations, each trade works independent of the others. Carpenters do only carpentry work, electricians only electrical work, etc. In developing the work sequence, the Planner/Estimator must consider the way the trades must be sequenced to accomplish the work requirements. Each time a trade goes to the work site, a separate job phase must be planned.

EXAMPLE

REQUIRED WORK:

Put a new wall into room 300 to divide the room into two rooms - 300 and 301.

WORK SEQUENCE:

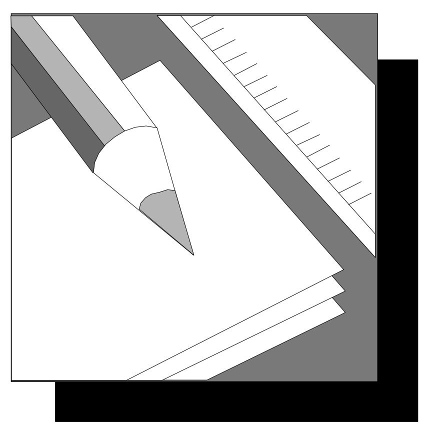
Carpenters: Frame in wall
Electricians: Rough in electrical requirements
Carpenters: Hang the dry wall
Painters: Paint walls
Electricians: Finish electrical work.

- **Multi-Trade Shops -** In recent years, many installations have gone to what is known as multi-trade shops. Although a craftsperson is a carpenter or electrician by trade, each craftsperson is required to help the other trades at the work site during the performance of the job. In the case of the above example in a multi-trade shop, the foreman would send an electrician and a carpenter to the site. The electrician acts as the carpenter's helper while the carpentry work is done and the carpenter assists the electrician with the electrical work. One or both craftspersons paint the wall.

It is important to initially sequence the job during the work planning process to establish the basis of the work plan. It also helps in the preliminary identification of the tasks associated with the accomplishment of the work requirement.

STEP #2: MAKE ROUGH SKETCHES

After a field visit and conference with the customer's Point of Contact, the Planner/Estimator should develop a rough sketch of the work requirement including dimensions and other relevant information. This sketch can help to identify the tasks associated with the work to be done and provide the basis for a rough estimate of the material quantities needed.

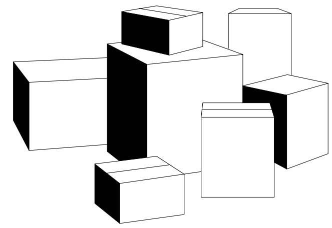


STEP #3: IDENTIFY THE WORK TASKS

For each phase in the sequence of work requirements, a preliminary list of tasks required to accomplish the job is developed. This list provides a starting point for identifying the standards to be applied when the detailed estimate is developed. It also gives the Planner/Estimator notes on which to base discussions about the work with the various shop foremen to be involved in the work accomplishment and with other Planner/Estimators who might be able to provide insight into methods and techniques for more effective work accomplishment.

STEP #4: IDENTIFY THE MATERIAL REQUIREMENTS

A rough estimate of the materials required for the job and the quantities of materials (including sufficient amounts for waste, cut outs, and trim-to-fit work) should be developed for each phase in the work sequence. Since material requirements are based on quantities of work, it is extremely important accurate measurements and sufficient notes are taken. This will allow as complete and detailed a material list as possible without making multiple trips to the job site.



STEP #5: DEVELOP AN ESTIMATE

The rough work plan forms the basis for the estimate to be made.

- **Scoping Estimates** - For each task identified in the rough plan, the Planner/Estimator identifies the appropriate unit of measure for the task and the number of units associated with the work requirement. Using one or several of the unit price standard estimating methods, an appropriate standard is selected for the task. The predetermined standard cost per unit is then multiplied by the number of estimated units of measure to obtain an extended cost per job requirement. When all the extended costs for the job requirements are added together, the total represents the scoping estimate cost for the job. Unit price standards include equipment and material requirements as part of the unit cost.

- **Detailed Estimates** - The rough plan provides the Planner/Estimator with a working document to be used as the basis for discussions with the shop and subsequent development of the detailed estimate.

3. <u>Interface with Shops.</u>

After the rough work plan is done, the Planner/Estimator should consider discussing the job with shop foremen. Their expertise, knowledge of shop resources, and familiarity with the facility can assist the Planner/Estimator in identifying:

- special equipment and material requirements
- additional tasks that may be required
- tasks that are not required

In the facilities maintenance organizations of today, many Planner/Estimators find themselves planning in trades in which they have little experience. Thus, identifying all tasks required to accomplish a job and ordering the right materials for the job may be difficult. Interfacing with the shop foremen and traveling out to the work sites together can improve the quality of an estimate and make the foreman's and planner’s job much easier. Two heads are often more effective than one.

D. DETAILING THE ESTIMATE

After the work requirements have been identified and the rough work plan developed, the detailed work estimate for the job is developed following these steps:

STEP #1: WRITE CONCISE PHASE DESCRIPTIONS

It is important that the phase description "stand alone" because the craftsperson is usually given only the phase descriptions and the attached sketches from which to work. The craftsperson should not have to call the Planner/Estimator or shop foreman for clarification.

CONCISE PHASE DESCRIPTIONS

- ***Allow the craftsperson to easily locate the work site***
- ***Determine the exact work requirements***
- ***Begin work within minutes of arriving at the site***

STEP #2: IDENTIFY THE WORK STANDARDS

Planner/Estimators have a wide variety of standards from which to choose. For maintenance and repair work, Engineered Performance Standards are engineered standards that have been developed specifically for this type of work. Planner/ Estimators should first look for the work tasks in EPS. If there are no applicable standards in EPS, other accepted standards methodologies should be investigated. As a last resort, if the task cannot be found in other standards application methodologies or manufacturers' guides, a "best guess" or local estimate can be made.

STEP #3: DEVELOP THE BILL OF MATERIALS (BOM)

The bill of materials is a concise listing of materials and parts required to perform the work in each job phase of the work sequence. The development of accurate bills of material is critical to efficient job accomplishment and the ability of Supply to effectively support the shops' work effort. Planner/Estimators must insure that the correct type, size, color, material composition, stock number, part number, and quantities are indicated on the bill of materials. Ambiguity in material identification may result in incorrect material orders or unsatisfactory material substitutes. Incorrect materials are not usually discovered until the work is about to begin, with the following possible results:

- work cannot begin
- incorrect materials returned to Supply
- correct materials reordered
- shop and Supply productivity impacted
- non-productive time charged to the job

Failure to order sufficient quantities of material to allow for waste or complex cuts can also severely impact both productivity and the labor hours charged to the job. A craftsperson may not be able to obtain needed materials from stock causing an entire work process to stop. In addition, other craft phases may not be able to do their work as scheduled, and the customer's facility may be left in disrepair until material arrives.

STEP #4: DEVELOP SKETCHES AND MAPS

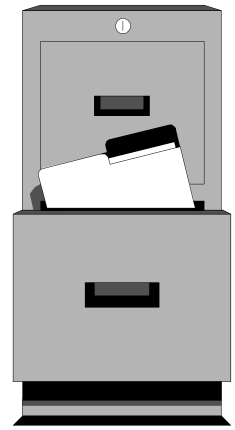
> **SKETCH**
>
> ***A drawing or sketch is one of the most effective ways of communicating a complex work requirement.***

The phrase "a picture is worth a thousand words" most certainly applies to work estimating. In many cases a simple site sketch can help both the Planner/Estimator and the craftsperson. In drawing the sketch and placing the measurements on the drawing, the Planner/Estimator can better conceptualize the work requirements and see the material requirements in their proper perspective. The sketch may help avoid the material shortage scenario described above. For the craftsperson, an attached sketch with a phase description can minimize job planning and allow the craftsperson to begin work within minutes of arriving at the work site. Something as simple as indicating a room's location within the building may save valuable craft time in locating the work site. A sketch may also affect where the craftspersons park their vehicle, saving them from parking at one end of the building only to find the work at the other end.

E. SUMMARY

The work estimating process is an essential component of Work Control. Scoping estimates are the basis for planning work accomplishment within the facilities maintenance system. Detailed estimates are the basis for ordering materials, scheduling and accomplishing work, and subsequently evaluating how well the facilities maintenance management system supports the craftsperson's accomplishment of work requirements. Not only the Planner/Estimators but all the facilities maintenance personnel need to understand the work estimating process and its integrated relationship with all functions of the facilities maintenance management system.

SECTION IV
SOURCES OF ESTIMATING DATA



There are five very broad categories of facilities maintenance estimating data. Within these categories are numerous sources of maintenance, repair, alteration, operations, and construction estimating standards. The categories of estimating data and location of some of the more well known sources of estimating data are presented below. In choosing from the categories and sources, Planner/Estimators should be aware of the applicability of the data to facilities maintenance and repair work requirements, the ease of use, and degree of accuracy provided.

A. HISTORICAL INFORMATION

Facilities maintenance Planner/Estimators have access to years of historical data related to operations, maintenance, and repair work performed at their installations. Historical data can be found in hard copy in Work Request files and facility history folders in installation work control offices. Dependent upon the thoroughness of the filing system, records may date back to the day a building was turned over to the installation. In electronic databases current jobs are usually resident in the active or historical directories with periodic purges sending the older historical records to archive files. Also in the electronic mode, Planner/Estimators may find some historical information on frequently repeated tasks stored as "local standards" in the system's standards database.

> **HISTORICAL DATA**
> - ***Provides the amount of time estimated to accomplish similar work***
> - ***Provides the amount of time spent accomplishing similar work***

The applicability of historical data to a job or task for which estimating information is being sought is questionable. Unless the Planner/Estimator searching is the Planner/Estimator who developed the original work package, the applicability of historical information becomes questionable because too many unaccountable variables exist. For instance, the questions arise:

- Were the working conditions the same?
- Did the work go as planned or was the scope changed and not recorded?
- Were the work requirements exactly identical?

Finding the historical information sought is often easier said then done. If the data is in the electronic system, the search may be easy; however, if it has been archived and stored, getting it back into the database may take more time, effort, and expense than simply producing a new estimate. Most hard copy historical job related information is not sorted in a manner that lends itself to easy retrieval. If it is filed by facility number, the search may prove easy when the facility number is known. However, if it is stored by work order number, date completed, type of work, or customer the search may be long, frustrating, expensive, and ultimately unsuccessful.

Similar to the applicability of the old job to the new, the accuracy of historical information may be unreliable. Age may have an effect on the methods, materials, and tools used and affect the new estimate. A comparison of the estimate to the actual hours may show that a significant variance occurred that was never resolved. Does the Planner/Estimator choose the actual or the estimated hours as the basis for the new estimate?

There is no way to know the answers to all the questions that arise when a historical job is selected as a source of work estimating data. To level off the numerous variables, averaging a number of similar jobs and using the mean as a standard improves the accuracy somewhat. This approach provides a better estimate than a single job because it levels off the extremes, but still leaves open for question the reliability of the work estimating data it provides.

B. EXPERIENCE

1. Planner Estimator.

Estimator and craft experience are two areas of another broad category of estimating data. In the commercial world, estimators often provide scoping estimates for roofing, siding, gutters and window replacement, heating and air conditioning replacement, etc. Their experience in the field, their knowledge of materials they routinely select, and the large number of estimates they make in the course of a year enable them to rely on their experience as a source of estimating data. These "ball park" estimates are provided to potential customers over the phone or at the conclusion of a site visit. They are not used to formally commit the company in a contract. If given over the phone, a site visit to validate the scope and site conditions is made and measurements taken so that material requirements can be determined. If based on a site visit, the detailed estimate is either developed on the spot or mailed within a couple of days of the visit.

Craft experience or estimating experience enables a Planner/Estimator to produce reasonably accurate estimates for specific kinds of work in a specific area. Experience can be rapidly applied to scoping or desk top estimates. If the Planner/Estimator keeps comprehensive field notes, the material requirements are easy to copy and modify as required to match the scope of the new job. The accuracy of experience estimates is only as good as the Planner/Estimator's estimating skill and memory.

2. Other Experts.

If the Planner/Estimator consults other persons for estimating information outside the Planner/Estimator's personal knowledge base, the variables associated with applicability and accuracy of the data increase. Questions arise:

- Is this individual's knowledge and experience really sufficient to accurately estimate the work requirements?
- Have they work requirements been clearly defined?
- Are the work requirements understood by the person who is to make the estimate?

For scoping purposes, experienced estimates by others may be sufficient. There are other Planner/Estimators and craftspersons at the installation and many commercial vendors who perform similar work in the neighboring communities. Unfortunately, determining the accuracy is difficult. Many times this information is provided off the top of the estimator's head based on their best recollection of a similar job that was done in the past. Personal biases must also be factored into the estimate. A foreman may tend to estimate high to ensure the shop has sufficient time to accomplish the work. A commercial vendor may estimate low because the work is routine for the company and therefore something the craftspersons do on almost a daily basis.

C. CONTRACT DATA

In recent years, an increasing amount of facility maintenance work has been performed by contract. Information on contract bids and government estimates is available in hard copy or in the maintenance management information system at the installation. In fixed price contracts, the contractor provides a price for the work and provides no detail in the invoice sent for reimbursement. Even if the estimate contains labor hours and materials for each work requirement of the job, there is no guarantee that those labor hours reflect what the contractor's work force might use for accomplishment of the work.

CONTRACT DATA

Basing an estimate on contract data is risky because the accuracy is totally unknown.

D. STANDARDS

A standard is defined as follows:

STANDARD

A measure of comparison or acceptability used as a bench-mark or yardstick for measuring actual performance.

In facilities maintenance management, standards provide a benchmark (expressed in either dollars or hours) for a defined amount of maintenance work to be accomplished. When work is completed, the standard becomes the basis for comparison of actual performance. The comparison can assist in finding:

- problems in the process which prohibit craftspersons from performing to standard
- where work processes promote performance allowing craftspersons to exceed the standard

Two types of standards data are available to facilities maintenance organizations.

1. <u>Proprietary Standards.</u>

Proprietary standards have been developed by both individuals and corporations in the private sector and are protected by copyright. Each source utilizes its own standards format. Proprietary standards are available commercially from the vendor. Sources of some well known facilities maintenance and construction standards and other estimating information resources are listed below:

MAINTENANCE STANDARDS SOURCE	ADDRESS
R.S.Means™ Cost Data Books & Automated Estimating Systems	R.S.Means Company Inc. 100 Construction Plaza P.O. Box 800 Kingston, MA 02364-0800 (617) 747-1270
Walker's™ Building Estimator's Reference Book (and other titles)	Frank R. Walker Company Publishers 5100 Academy Drive Lisle, IL 60532 (312) 971-8989
Construction Criteria Base (CD-ROM)	National Institute of Building Sciences (NIBS) 1201 L Street NW # 400 Washington DC (202) 289-7800
Richardson's™ General Construction Estimating Standards	Richardson Engineering Services, Inc. P.O. Box 9103 Mesa, AZ 85214-9103 (602)497-2062
Estimator's Man Hour Manuals by John S. Page	Gulf Publishing Company Book Division P.O. Box 2608 Houston, Texas 77001 (713)529-4301
Construction Estimating Reference Data (32 other related subject titles)	Craftsman Book Company 6058 Corte del Cedro Carlsbad, CA 92009 (619) 438-7828

The methods used to develop proprietary standards vary among the companies that develop them and are proprietary to the company. On the whole, proprietary standards development firms do not use engineering techniques in their development processes. In many cases, however, it is known that experts are surveyed to determine the time it takes to perform a particular task and the amount of materials and equipment associated with the work.

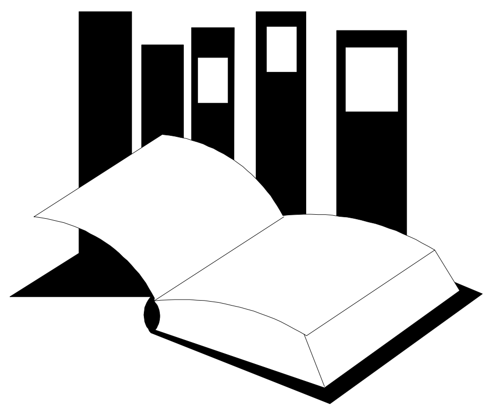
Some hard copy sets of proprietary standards manuals are usually available to the Planner/Estimator. Since these proprietary standards are costly to acquire and keep current, most facilities maintenance organizations chose one vendor or another and purchase one or two sets. The sets are broken up based on the trades in the various volumes and distributed to the Planner/Estimators with the lead responsibility for particular trade estimating.

Some proprietary standards are also available in automated formats including CD-ROM and disk formats. Since cost is a significant factor in acquiring these standards databases and licenses to operate the software, the data , if purchased and installed, may have limited availability for use by all Planner/Estimators.

Some proprietary standards such as R.S.Means™ and Walkers™ are arranged in the Construction Specifications Institute (CSI) master format. CSI is a system of classification and numbering widely used and accepted in the construction industry for estimating. The CSI format contains 20 Divisions as shown below:

CSI Division 1-General Requirements
CSI Division 2-Site Work
CSI Division 3-Concrete
CSI Division 4-Masonry
CSI Division 5-Metals
CSI Division 6-Wood and Plastics
CSI Division 7-Thermal and Moisture Protection
CSI Division 8-Doors and Windows
CSI Division 9-Finishes
CSI Division 10-Specialties
CSI Division 11-Equipment
CSI Division 12-Furnishings
CSI Division 13-Special Construction
CSI Division 14-Conveying Systems
CSI Division 15-Mechanical
CSI Division 16-Electrical
CSI Division 17-Square Foot
CSI Division 18-Miscellaneous Items
CSI Division 19-Selective Demolition
CSI Division 20-Miscellaneous Modification Items

Each CSI Division is broken down to sub-divisions consisting of a five digit identifier starting with the Division number (i.e. 08100 Metal Doors and Frames is a sub-division of CSI Division 8-Doors and Windows.



Most proprietary standards sources are well indexed and easy to use. Vendors generally offer standards application training at centralized training sites throughout the country. The databases are generally updated on a periodic basis because labor rates and material costs change from year to year. It is up to the user organization to ensure that the standards being referenced and applied are current to maintain the accuracy level of the estimate.

In applying any work estimating standards methodology, accuracy is affected by the Planner/Estimator's ability to identify the work requirements and plan the job. Selection of the applicable standard from the choices available, the accuracy of unit requirements and mathematical calculations, the crew composition, and local labor and material cost factors are all an integral part of estimating accuracy.

2. <u>Public Domain Standards.</u>

Standards available in the public domain, in most cases, have been developed either for or by the government and are not protected by copyright. They are available to government agencies and the public at a reasonable (reproduction) cost and in some cases at no cost. Facilities maintenance standards in the public domain include the following:

MAINTENANCE STANDARDS	SOURCE
Engineered Performance Standards (EPS) Inspection Standards	Naval Facilities Engineering Command Industrial Engineering Center Commander, Atlantic Division Naval Facilities Engineering Command ATTN: Code 165 1510 Gilbert Street Norfolk, VA 23511-6287 (804) 322-7701 DSN 262-4701
PAVER, ROOFER, and RAILER and other specialty maintenance and repair work standards	U.S. Army Construction Engineering Research Laboratory P.O. Box 9005 Champaign, IL 61826-9005 (800) USA-CERL
Job Order Contracting (JOC) Standards	U.S. Army Center for Public Works Fort Belvoir, VA 22060-5516 (703) 355-2300

The proponent agencies for many of these public domain standards databases have made the databases and standards updates available to the general public for downloading from electronic bulletin boards. Most of these standards databases are available to Planner/Estimators on personal computers or incorporated into standard automated management information systems such as the U.S. Army Integrated Facilities System - Micro/Mini (IFS-M), the Public Works Management Automation (PWMA) system, the U.S. Air Force Work Information Management System (WIMS), and the Marine Corps Real Property Maintenance/ Family Housing System (RPM/FHS).

Methods of development for public domain standards vary. Engineered Performance Standards are engineered using industrial engineering techniques and developed specifically for facilities maintenance and repair work. The Job Order Contract standards are developed for the Corps of Engineers by the Construction Inspection Institute using R.S Means™ standards and Corps of Engineers unit pricing data. The U.S. Army Construction Engineering Research Laboratory management engineering systems PAVER, RAILER, and ROOFER are constructed so that maintenance and repair estimates are based on each installation's historical maintenance and repair cost data.

Public domain standards are applicable for a variety of types of facilities maintenance and repair estimates. For instance, PAVER is for road maintenance work, EPS is for facilities maintenance, repair, and preventive maintenance work, and JOC is used in contracting for minor maintenance and alteration work.

All public domain standards require application training. The automated versions require both application and software operation training to teach the user how to navigate through the electronic screens. As with all standards, accuracy depends heavily on proper application and sound work planning prior to selecting the standards.

E. SUMMARY

Planner/Estimators have substantial amounts of work estimating information available from a wide variety of sources, the applicability and accuracy of which is equally as varied. However, because facilities maintenance work covers such a broad spectrum of work requirements, a Planner/Estimator may find that a single job requires work estimating information from several sources. It is important that Planner/Estimators are familiar with the available sources and the application techniques that go with them.

SECTION V
STANDARDS

In facilities maintenance management, using work estimating standards provides the organization with a number of benefits. Engineered standards, in particular, provide some very specific benefits to a facilities maintenance management organization. These benefits are typical for engineered standards.

A. BENEFITS OF USING STANDARDS

1. Uniformity and Consistency.

Engineered standards are typically developed using a reliable and proven engineered process. Because of this process, and the standard method of application, the data can be uniformly applied with consistent results for labor hour estimates. Generally, standard data can be applied anywhere similar units of work exist.

2. Level of Accuracy.

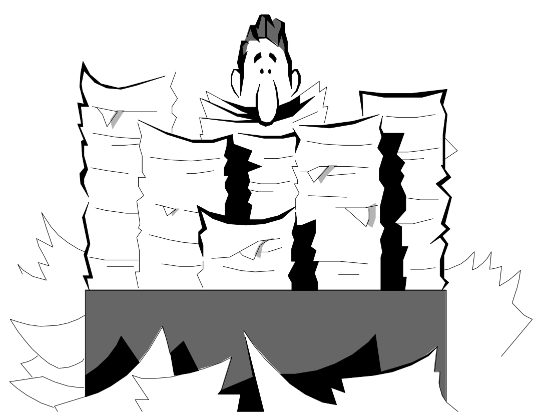
Standard data, as a result of being based on motion time development techniques is as accurate as possible for the work described in the standard. Time associated with maintenance work does not lend itself to having pinpoint accuracy; however, standards estimates increase in accuracy as the scope of work increases.

3. Improved Planning.

Planner/Estimators using standards must describe the total job by detailing each of the smaller tasks. The result is usually a better job plan which helps coordinate each of the crafts involved setting the stage for proper scheduling and smooth accomplishment of the work.

4. Improved Backlog Management.

Confidence in budget requests for annual and backlogged maintenance and repair funding requirements is gained when standard data is used to develop estimated labor and material costs for maintenance and repair work. To effectively manage backlog, facilities maintenance managers must have an accurate picture of how much backlog work exists. Work estimated using engineered standards most accurately depicts the requirements. It provides a clear picture of potential work shortages or overloads that will subsequently affect productivity. In the event of an audit, estimates developed using engineered standards need no further justification of the estimated cost.



5. Improved Scheduling.

Logically sequenced craft phasing helps the Scheduler to plan each phase of work.

6. Improved Work Accomplishment.

Engineered standards provide craftspersons with adequate amounts of time to perform high quality maintenance and repair work. Standards based estimates also help improve shop performance by allowing the craftspersons to work toward a time goal which they feel is justified and fair.

7. Effective Measures for Productivity Improvement.

Engineered Performance Standards offer quantifiable benchmarks which can be used to compare actual work accomplishment to estimates. These comparisons help to determine whether work is being accomplished productively. The work accomplishment process can easily be analyzed using work estimates as the basis for measuring productivity and identifying work accomplishment process problems. EPS promotes trend analysis to determine where the work process is breaking down or where innovative improvement ideas are enhancing it and, thus, improving work productivity.

B. TYPES OF STANDARDS

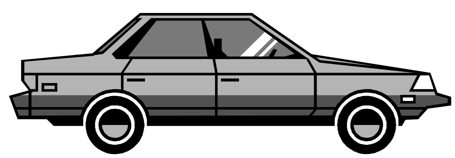
Work processes govern the type of standards required for work estimating. There are maintenance and repair standards for machinery, equipment, vehicles, and facilities; production standards for manufacturing processes such as vehicles, appliances, clothing, etc.; and construction standards for every facet of new construction work. Understanding the differences in these three work processes explains the differences among the three types of standards.

TYPES OF STANDARDS
Production
Construction
Maintenance & Repair

1. Production Standards.

Most production work is repetitive and the work place and methods are normally fixed. The standards applicable to production work normally consist of the following parameters:

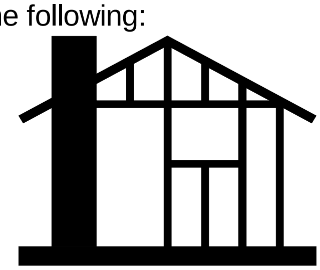
- short periods of time for complete operation
- regimented working conditions (e.g. production line)
- repetitive operation
- exact work methods
- exact work content for each operation
- pinpoint accuracy consistently achievable



2. New Construction Standards.

New construction work is similar to production work in terms of methods of accomplishment and standards. New construction standards normally consist of the following:

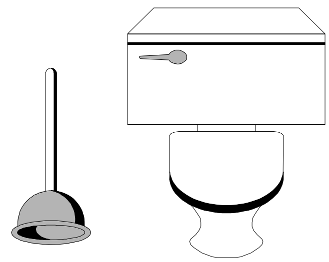
- short to moderate periods of time for complete operation
- minimal working condition impediments
- repetitive operation
- exact method or installation parameters specified in prints and specifications
- exact work content for each operation
- work site prepared for installation
- accuracy based on industry averages and consistently achievable by standard crew



3. **Maintenance and Repair Standards.**

Unlike production and new construction work in which the working conditions are relatively unobstructed, maintenance work takes place in less than idyllic conditions. Often times, an integral part of a maintenance or repair requirement is the removal or disassembly of existing facility components, machinery, parts, or structures and the subsequent retrofit or rebuilding with new materials or equipment into existing spaces. Standards set for maintenance and repair work normally consist of the following parameters:

- large scope of time required
- restrictive working conditions
- non repetitive tasks
- accepted method(s) not always applicable or useable
- variable work content each time the task is performed
- level of accuracy of the total job time estimate is directly proportionate to the size of the job



C. SELECTING THE RIGHT TYPE OF STANDARD FOR THE JOB

As the parameters for the three types of standards illustrate, using production or construction standards for maintenance and repair work requirements is an inappropriate choice. The differences in the working conditions, the nature of the tasks to be performed, and the broad range of work scope make maintenance and repair work less predictable than construction and production work. However, because maintenance and repair work seems to have a great deal in common with new construction work, a tendency exists to inappropriately apply construction standards to it. Construction standards applied to maintenance and repair work may result in inaccurate maintenance and repair estimates.

When Planner/Estimators understand the differences among the various types of standards, they can begin to be selective in their application of standards to estimates they are required to develop. Combinations of work types frequently arise in alteration type projects. By appropriately combining construction and maintenance and repair standards, the Planner/Estimator can develop well planned estimates that accurately reflect the work requirements of the job and provide sound estimates for planning, scheduling, work accomplishment, and work evaluation within the facilities maintenance management system.

D. ACCURACY

There are differences in the levels of accuracy among the three types of standards. Production standards achieve pin-point accuracy, especially when developed for a production line environment. An established production rate of five pieces per hour is consistently achievable on an hourly basis and should always be achievable on a daily and weekly basis baring breakdowns in the line or supplies to the line.

TIME IS MONEY.

Construction standards have high accuracy levels as well. Trades are scheduled only when the site is ready and prepared for their construction installation phase. There are little or no obstructions to be worked around when the mechanical contractor is called to install ducting for the central HVAC system. Likewise, the crew installing doors and windows finds the building framed out and ready to accept the prefabricated windows and pre-hung doors. Work crews go from point to point doing essentially the same operation with the same work content for each door and window installed.

To develop construction standards, a firm such as R.S. Means™ may develop a construction standard on survey data collected for an average daily output for a carpenter and helper to install 10 average quality, builders' model 2' x 3' double hung windows with insulating glass, including frame, screen and exterior trim. This method for setting standards produce reasonably accurate standards for construction that are accepted throughout the industry.

Figure G-6 illustrates the accuracy level achievable in the application of production, construction, and maintenance work standards.

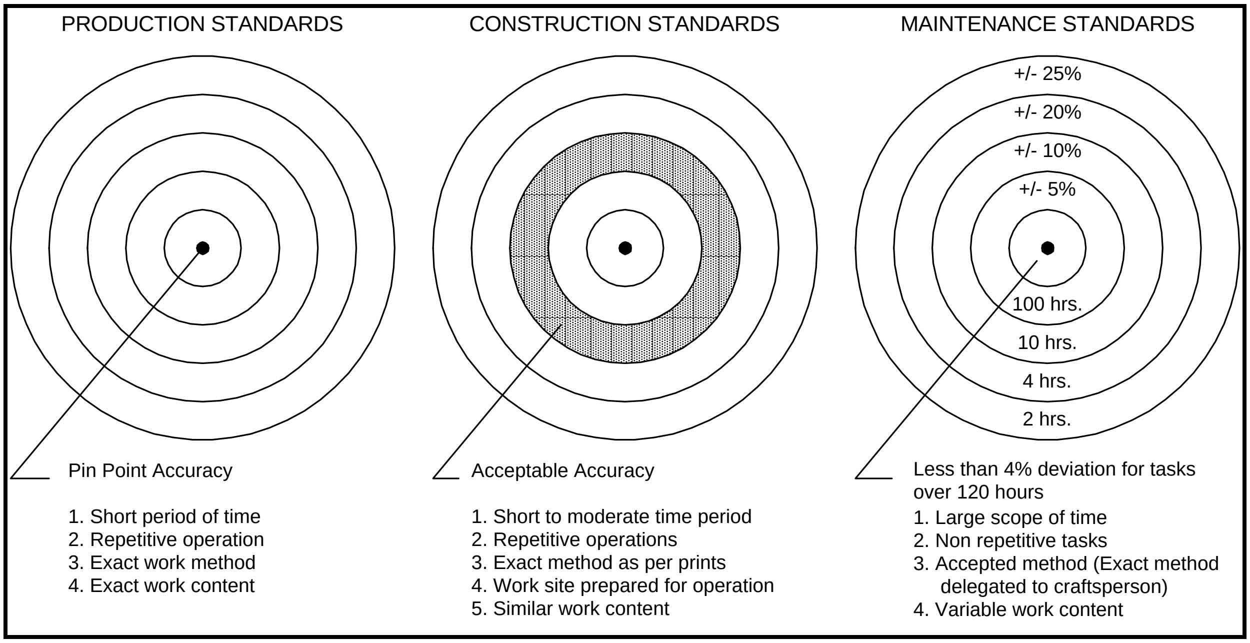


Figure G-6. Production, Construction, and Maintenance Standards Characteristics

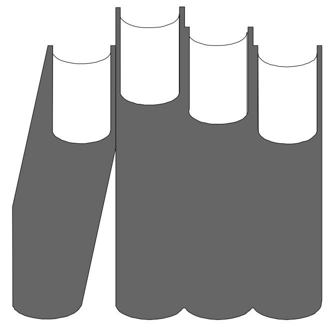
Maintenance standards cannot achieve the accuracy levels of construction and production standards. Although they need to be as accurate as possible, they simply cannot be expected to be exact for each and every job because no two maintenance and repair jobs are exactly alike. In maintenance and repair standard application, the larger the job the more accurate the standards become, whereas, in production and construction standards application, quantity of work has little or no affect on accuracy.

The percentages shown in Figure G-6 suggest how to consider maintenance standards accuracy. These percentages do not imply an "allowed" error range, nor should they be considered hard and fast guideline percentages. They simply suggest that tasks taking about 2 hours or less to perform may only be accurate to ±25%, tasks taking 10 hours are more accurate at ±10%, and those over 120 hours should only have a margin of error of ±4% estimated to actual time. The more time required for a maintenance or repair job the more accurate the estimate becomes if the standards have been properly applied.

E. SUMMARY

The entire facilities maintenance management organization benefits significantly from the use of standards as a work estimating tool. Improved planning, budgeting, scheduling, work accomplishment, and work evaluation are the results of proper application of standards. Choosing the correct standard type for the work to be estimated and correctly applying the standards from the various sources are the responsibilities of the Planner/Estimator in the organization. Therefore, it is essential the each Planner/Estimator understand the differences among the types of work and learn how to select appropriate standards for the estimates to be developed.

SECTION VI
ENGINEERED PERFORMANCE STANDARDS BACKGROUND

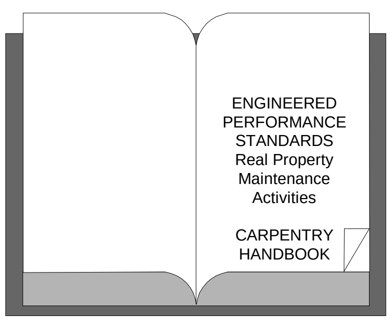


Engineered Performance Standards (EPS) is one of many sources of facilities maintenance and repair standards. Developed by the Department of Defense for use by the Department of Defense, it is the only source of facilities maintenance and repair standards that is designed specifically for maintenance and repair work.

A. THE HISTORY OF EPS

In the early 1950s, the Department of Defense (DOD) became concerned about managing real property maintenance activities. All the services faced a growing problem of maintaining an ever increasing inventory of facilities (many of which were World War II vintage) being utilized far beyond their original designed life capacity. Where breakdown maintenance had been the operating policy, the new direction was to raise the level of maintenance so that these facilities could continue to be utilized. However, no additional resources were provided. In the meantime, accelerated new construction programs continually added more maintenance and repair requirements as permanent facilities were completed and turned over to the Government.

To realize the fullest and most efficient utilization of available resources, industrial engineering procedures and techniques were applied and maintenance management systems developed. Within its framework came the idea of developing standards for maintenance work. This effort beginning in 1957, formed the basis for the Navy's system. Several years later the Army and Air Force, who had been developing standards of their own, adopted the Navy's more advanced Engineered Performance Standards program for estimating maintenance work.



In the early 1970s, standards application within each Department of Defense component varied depending on local command interest or knowledge. In 1976, a memorandum from the Office of the Assistant Secretary of defense established the Department of Defense policy for increased effective use of EPS in RPMA within available resources. The Navy was designated as the lead service to revise, update, and maintain EPS. The Army, navy, Air Force, Marine Corps, and Defense logistics Agency were tasked to provide annual EPS support funds.

The Naval Facilities Engineering Command (NAVFAC) Industrial Engineering Center (NIEC) was established in February 1977. The NIEC's mission was to provide Department of Defense with RPMA standard time data based on the latest work methods. It was also charged to maintain and keep current the EPS standards manuals, training manuals, databases, and application procedures. In subsequent years, as automated systems have been developed to facilitate EPS application and integrate the estimates into standard management information systems that support facilities maintenance management systems, the NIEC was given the added technical responsibility for ensuring that automated estimating systems contain the most updated standards and that they are correctly applied.

B. EPS DEFINITION

Engineered Performance Standards are facilities maintenance and repair standards that have been developed by engineers using proven industrial engineering techniques. Many years of experience and expertise have gone into the derivation of these standards to make sure that they are applicable for maintenance programs. Unlike many other standards, they are developed based on the actual observation of maintenance workers performing the work.

ENGINEERED PERFORMANCE STANDARD

*The **average** time necessary for a **qualified** worker, working at a **normal pace,** under **capable supervision** and experiencing **normal delays**, to perform a **defined amount of work**, of a **specified quality**, while following **acceptable trade methods.***

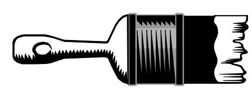
Each standard represents the amount of time it **should** take under normal work conditions to perform a given amount of work. Obviously, the terms *normal, average,* and *qualified* mean different things to different people, but EPS has been developed based on conditions which represent the norm.

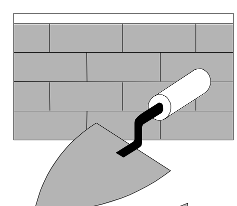
EPS data is a tool used by Planner/Estimators to develop consistent, uniform, and accurate facilities maintenance and repair estimates. Any trained Planner/Estimator who has a working knowledge of craft work should be able to develop good labor hour estimates using these standards. Then, as discussed in previous sections, the work estimates can be used to support various functions within the facilities maintenance management system.

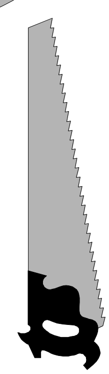
C. ADVANTAGES OF EPS

1. <u>Design</u>.

Engineered Performance Standards are designed specifically for facilities maintenance type work through the observation of maintenance workers at work. The work is measured through the use of proven industrial engineering techniques such as Methods-Time Measurement (MTM), work sampling, and time studies. They are designed to relate a given amount of work to the labor hours needed to accomplish the work.







2. <u>Transferability</u>.

EPS estimates are based on the labor hours needed to do a specified amount of work under normal conditions. When EPS is properly applied under those normal conditions, the craft time should be valid at any work site in any geographical location.

3. <u>Productivity Measurement</u>.

EPS is the only facilities maintenance work estimating source that provides consistent measures of maintenance work productivity. As a benchmark EPS provides a means of measuring productivity. The variance between EPS estimates and the actual labor times can be evaluated to identify work process problems impeding both the productivity of the work force and the quality of the work output.

4. <u>Accuracy</u>.

Facilities maintenance work does not lend itself to having pinpoint accuracy for any particular single job or task. Rather, the accuracy of EPS based estimates increases as the size of the job increases and the effect of averaging levels the variables stated in the EPS definition: normal pace, capable supervision, normal delays, and acceptable trade methods.

5. Practicality.

Engineered Performance Standards are developed and consistently applied so that Planner/Estimators can estimate a greater variety of jobs with increased accuracy, in less time, and with less formal data than using conventional data. All EPS data is applied in the same way.

D. EPS DEVELOPMENT

Three proven industrial engineering techniques form the basis of EPS development.

1. Methods Time Measurement (MTM).

MTM is a system of predetermined time standards which provides a precise measuring method for human motions. It was developed and is maintained by the MTM Association in Fair Lawn, New Jersey. Using video tapes of maintenance craftspersons performing a specific work task, a detailed analysis of each motion is made to determine every element associated with the work operations being performed. The exact time of basic motions used to accomplish work is measured in Time Measurement Units (TMU). These basic time elements are universal and can be used to develop a time standard for almost any work requiring hand, body, or eye motions such as reach, grasp, move, position, release, etc.

TMU
One Time Measurement Unit = 0.00001 Hours

2. Time Study.

Time study or stopwatch observations are used in EPS development to determine the amount of time for elements not fully controlled by workers. For example, machine time to fabricate an item, filling a tank, or driving a piling are all dependent upon the speed of the equipment used in conjunction with the accomplishment of the work. Time study is also used to validate the reasonableness of the overall times developed by other techniques. In addition, time studies are used as the basis for developing Travel Zone Maps used by the Planner/Estimator to apply round trip travel to and from the work site.

3. Work Sampling.

Work sampling is an industrial engineering technique used primarily in EPS to determine the percentages of work or delays associated with EPS allowances such as job preparation and craft allowances. Work sampling is the observation of a worker during a specified time range such as a shift, a work day, or at random intervals over longer periods of time. At specified intervals, the observer notes the worker’s specific activity. Numerous work sampling observations by trained observers result in very high statistical confidence in the percentages of work and associated delays experienced by craftspersons.

E. ENGINEERED PERFORMANCE STANDARDS

Through the application of MTM, Engineered Performance Standards are built based on the observation of work being performed. For illustration purposes, Figure G-7 illustrates the EPS task development process.

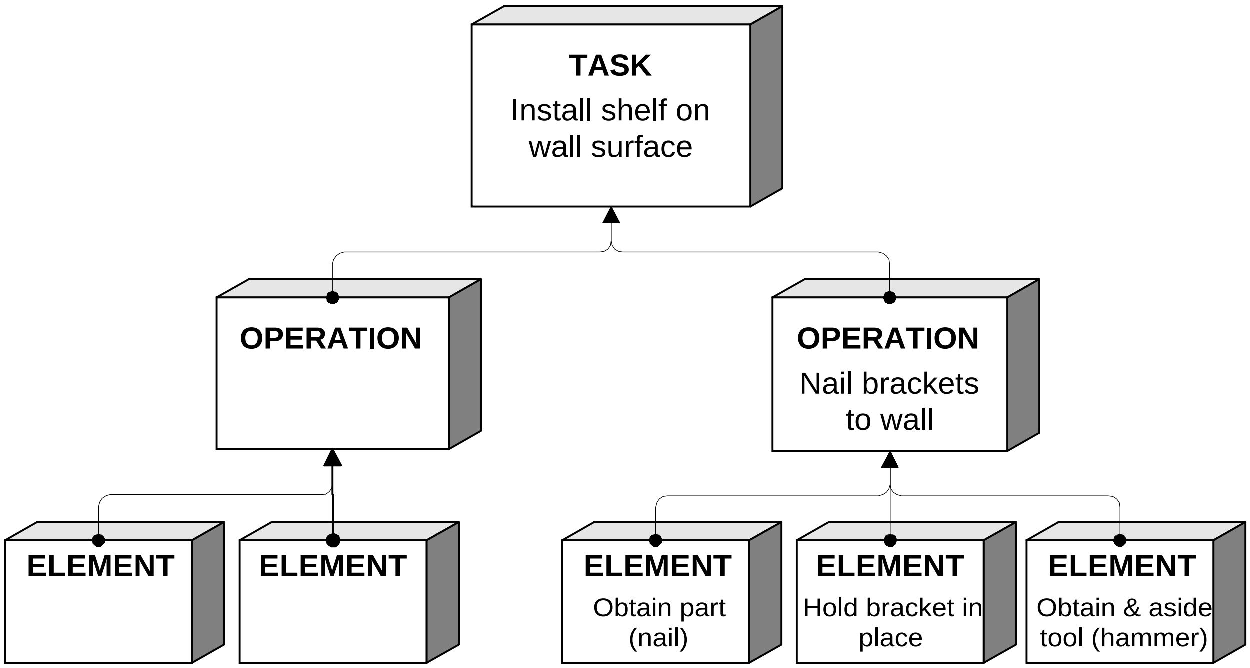


Figure G-7. EPS Task Development

1. <u>EPS Element</u>.

EPS elements are the smallest work unit in a standard. EPS elements are a composition of basic motions and/or machine or process activities that are distinct, describable, and measurable. For example, the EPS element *OBTAIN AND ASIDE TOOL* combines several basic MTM elements (e.g. reach, grasp, move, position, release).

2. <u>EPS Operation</u>.

An EPS operation is a series of related EPS elements performed by workers that results in a desirable change in location or condition of maintenance materials or parts. For example, to obtain a hammer, hold a bracket, drive a nail, and aside the hammer could constitute an EPS operation.

3. <u>EPS Task</u>.

An EPS task is a combination of operations that result in a specific amount of work that can be performed by a single craft with a specified time required to accomplish it. Each task time standard (TTS) shows the labor hours required to perform the work described and is used as a basis for information presented in the EPS craft handbooks. An example of an EPS task is to *INSTALL A SHELF*. It consists of the operations of measuring the wall, handling material, positioning the shelf and brackets to the wall, nailing the brackets to the wall, and positioning the shelf on the brackets.

F. EPS BUILDING BLOCKS OF TIME

Work estimates in which EPS is properly applied are actually developed by assembling "blocks of time". These blocks of time include craft task requirements (Craft Data), task requirements used by all crafts (Universal Data) and job preparation, craft delay allowances, and travel time (General Data). Each of these blocks is needed to arrive at the total Allowed Job Time for the job. Figure G-8 shows the blocks of time that make up a complete EPS estimate.

5

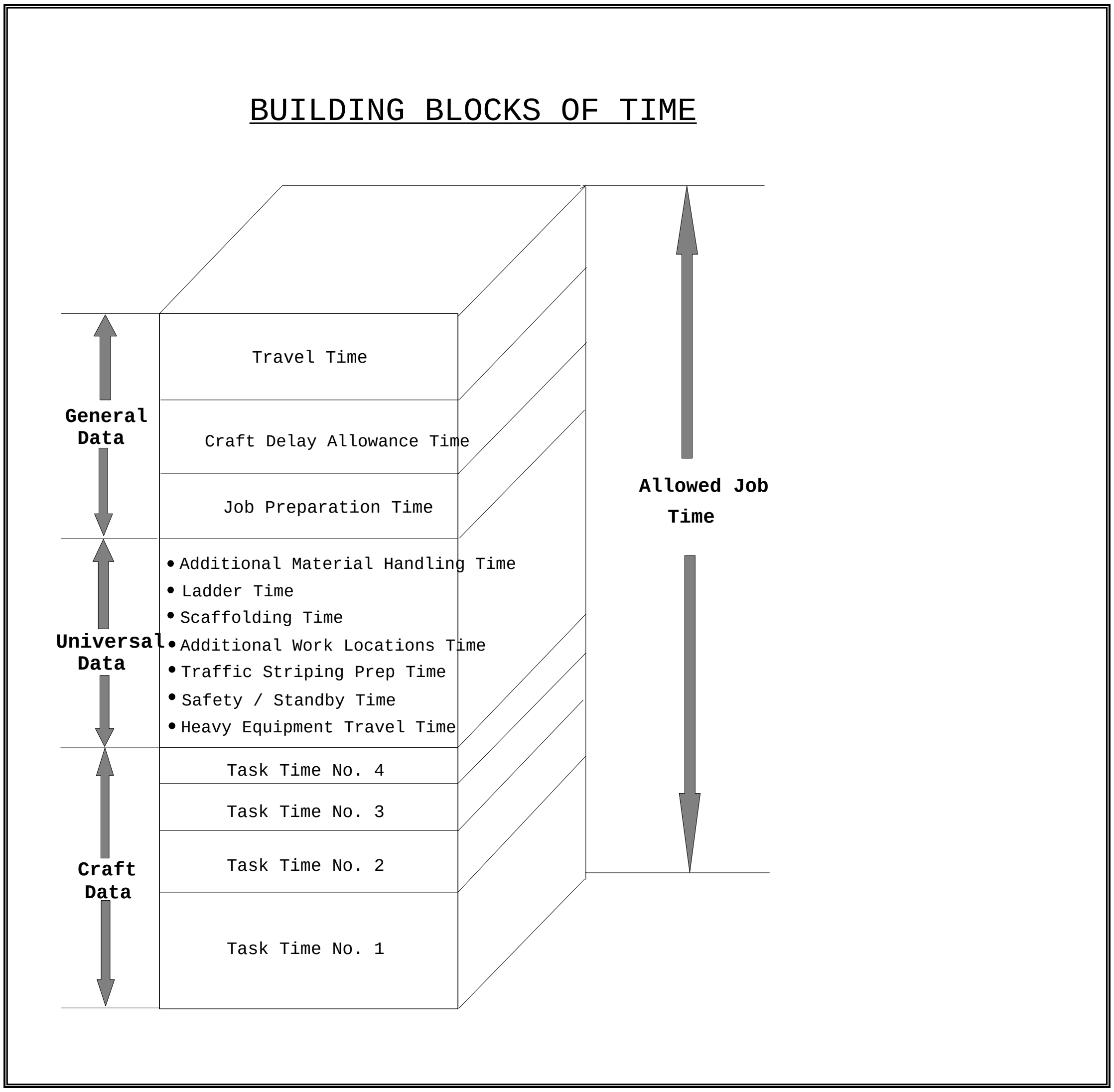


Figure G-8. EPS Estimate Building Blocks of Time

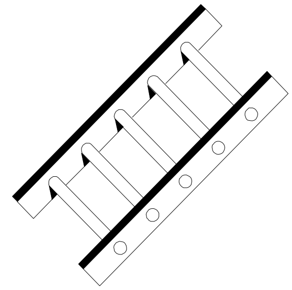
1. <u>Craft Data</u>.

Craft data includes all craft related task times derived from Engineered Performance Standards.

2. <u>Universal Data.</u>

Universal Data is Engineered Performance Standards task time applicable to all crafts. It includes:

a. Additional Material Handling (AMH). Time allowed to move materials from one location to another.



b. Ladder Time. Time allowed to use a ladder in performing a task.

c. Scaffolding Time. Time allowed to assemble *or* disassemble, move, raise, and lower scaffolding based on the number of scaffold sections required for the job.

d. Traffic Striping Machine Time. Time allowed at the end of each day to clean the paint striping machine during road marking jobs.

e. Standby/Safety Time. Time allowed for a safety person or standby person in support of the craftsperson(s) performing the task.

f. Additional Work Location (AWL). Time allowed for craftspersons to move to different locations either within a facility, between facilities, or within the same travel sector.

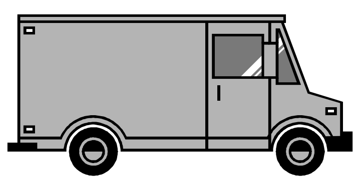
g. Heavy Equipment Travel (HET). Additional travel time allowed for heavy or large equipment which normally travel at below normal speeds.

3. <u>General Data.</u>
The general data provides the time required for:

a. Job Preparation. Time to get ready for the job and time to "finish up" after the craft work has been completed.

b. Craft Delay Allowances. A percentage of craft time that either supports the accomplishment of the job or is an unavoidable delay that is an inherent part of facilities maintenance repair work and cannot be avoided. It includes planning, balancing delays, personal time, and unavoidable delays.

c. Travel. One round trip, per craftsperson per day between the shop and the job site.



SECTION VII
WORK EVALUATION

A. OVERVIEW

The facilities maintenance management system is not complete unless the efficiency and effectiveness of the work being performed is analyzed, as shown in Figure G-9.

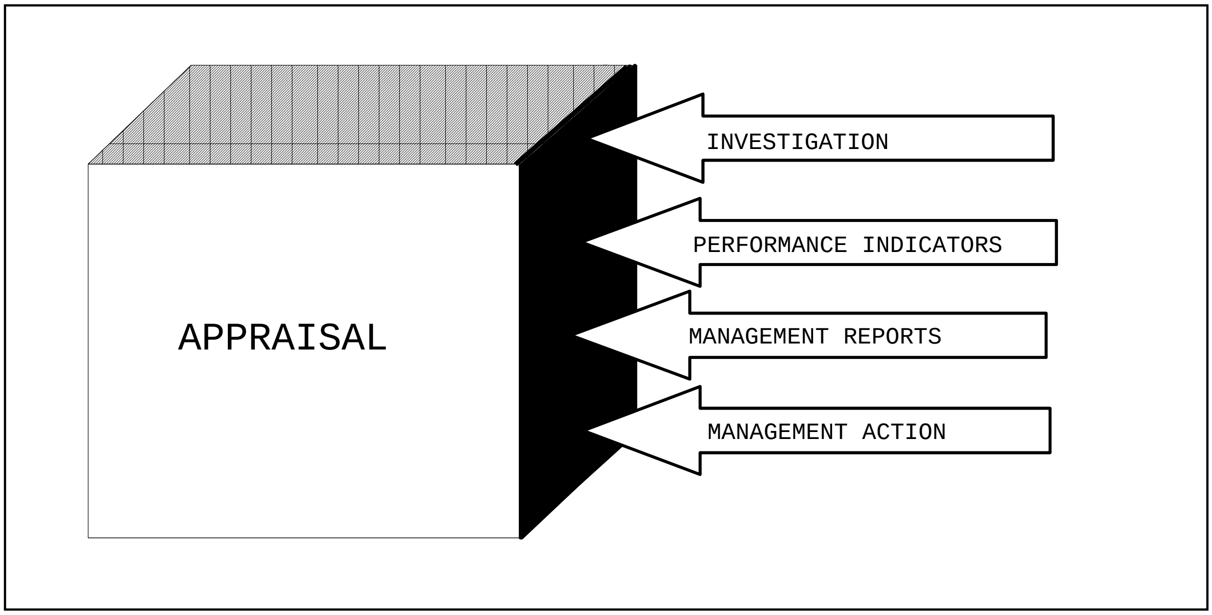


Figure G-9. Appraisal

1. <u>Reports</u>.

When work is completed, completed job data is compiled into reports showing estimated versus actual labor hours and costs expended. This data is forwarded to management personnel for variance analysis and management action.

2. <u>Variance Analysis and Performance Indicators</u>.

Careful variance analysis of management reports aids in determining the root causes of unusual situations occurring during work accomplishment. This analysis should be conducted shortly after work completion to allow for further investigation.

Performance indicators are a management tool within the work appraisal process. Management reports based on work data provide information for establishing performance indicators. Some of the many useful performance indicators may be used to monitor:

- labor, equipment, and materials expended
- actual versus estimated costs
- actual versus estimated labor hours
- job status
- work accomplishment

Tracked over time, these indicators provide a basis for comparative analysis, data for performance appraisals, and as a basis for decisions regarding whether corrective actions are needed to improve work processes. Analysis can also be conducted to determine whether previously implemented corrective actions are proving effective.

3. Investigation.

In order to determine what job situation occurred to cause a variance, an investigation of the previously completed work must be undertaken. The results of this investigation should point to the root cause of the problems causing the variance and pave the way for management action.

4**. Management Action.**

Soon after a determination is made on the causes of the problem areas, managers may be able to find methods for corrective action. Once implemented, reoccurrence of similar problems in the future may be eliminated or reduced.

5. Analysis Tools.

Some of the problems resulting in significant variances are readily obvious, and the required action which must be taken to prevent or reduce reoccurrences of these large variances is evident. In many cases, however, the causes underlying large variances between estimated and actual work are problems imbedded in the maintenance management system processes. In order to discover and quantify problems affecting the work processes and productivity of the maintenance management system, management may need to utilize analysis tools that are based on industrial engineering techniques.

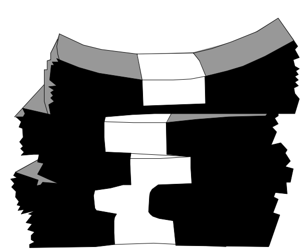
a. Methods Analysis. Methods analysis can be applied to all procedures pertaining to operations and includes the use of studies and analyses of processes, methods, motions, materials, tools, and equipment. Methods analysis consists of systematic procedures for gathering and analyzing data regarding all elements of the work to identify and develop improved methods of work accomplishment.

b. Process Charts. Process charts can be used to illustrate events that occur during a series of actions or operations. Process charts record all aspects of a process to obtain a better understanding and improve current operations.

c. Work Sampling Studies. Work sampling is a statistical approach to estimating a population's characteristics by examining a portion or representative sample of that population. Work sampling is a tool for assessing the productivity of a group within the maintenance management system. It is also useful for identifying and quantifying the problems adversely affecting system productivity.

d. Time and Motion Studies. Similar to work sampling studies, time and motion studies are also used to measure and evaluate work activity. Time and motion studies are used to obtain reliable data regarding the time required to complete a particular work segment.

e. Economic Analysis. Economic analysis is a systematic technique for measuring issues where cost is the major consideration. Economic analysis allows for comparing, contrasting, and evaluating the economic feasibility of two or more alternatives. This technique is particularly useful in assessing the feasibility of upgrading or replacing existing equipment which may be hindering the productivity of the workforce.



f. Performance Indicators. Performance indicators are a management tool used by managers as an integral part of the work appraisal process. Management reports based on work completion information provide the data for establishing performance indicators. These indicators include labor, equipment, and materials expended; actual versus estimated costs; actual versus estimated labor hours; job status; and work accomplishment. Tracked over time, these indicators provide a basis for comparative analysis, data for performance appraisals, and a basis for decisions regarding whether corrective actions are needed to improve work processes or whether previously implemented corrective actions are proving effective.

Performance indicators can be developed for virtually any measurable activity. Several examples of performance indicators which can support variance analysis are listed below.

(1) Shop Effectiveness Rate. This indicator is a percentage comparing the estimated hours of each job phase to the total hours charged to each completed job phase. This indicator provides management with feedback regarding both the shop and the planner/estimator.

(2) Amendments. Foreseeable job requirements not recognized by the Planner/Estimator frequently cause cost overruns due to work stoppages and/or supply shortages. This indicator, based on a sample of completed jobs over a specified time period, provides insight into estimating quality and thoroughness.

(3) EPS Utilization. This indicator shows the percentage of Work Request hours estimated using EPS compared to the total Work Request hours estimated during the same time period. Since EPS is the best estimating tool for maintenance and repair work, larger variances may be expected for maintenance and repair work estimated using other standards as the basis for the estimates.

(4) Staged Jobs. This indicator can be used to track the percentage of Work Requests on a short range shop load plan which have materials staged in supply for pickup by the craftsperson. EPS does not account for excessive time spent in supply obtaining materials for jobs to be accomplished. Jobs for which materials are not prestaged prior to craftsperson arrival at supply often result in excessive time being charged to the job, contributing to high variances.

Figure G-10. Job Variance Analysis Checklist

WORK CENTER:	WORK ORDER:	DATE JOB COMPLETED:	

ITEM #	DESCRIPTION (EXPLAIN REASONS)	YES	NO
1.	Was the job scope or estimate changed after the job was started?		
2.	Was the change sent to Planning for a revised estimate?		
3.	Were there any unusual delays during the job?		
4.	Was the job accomplished differently than planned?		
5.	Were materials complete before the job was started?		
6.	Were substitute materials used?		
7.	Was travel time & return to the shop for lunch figured properly?		
8.	Were any of the following encountered & not charged to overhead?		
a.	Maintenance & repair of shop tools and equipment on the job?		
b.	Excessive waits for materials?		
c.	Excessive waiting for transportation/equipment?		
d.	Excessive wait for job assignment?		
e.	Delay due to weather?		
f.	Shop clean-up?		
g.	Inspections?		
h.	Medical?		
i.	Other (explain):		
9.	Was work stopped by Management for any of the following		
a.	Training Classes?		
b.	Safety meetings?		
c.	Charity or bond campaign?		
d.	Personal problems/counseling?		
e.	Other (explain):		
10.	Were workers pulled from this job for emergency service response?		
11.	Was the labor hour data for this job captured accurately?		
12.	Was labor hour data input properly to the computer?		
13.	Do the JP&E and computer time estimates match?		
14.	Did the Planner visit the job site while planning the job?		
15.	Was the job properly planned using EPS where applicable?		
16.	Was a JP&E Worksheet completed for each phase?		
17.	Were correct EPS references used?		
18.	Was additional material handling time given (if required)?		
19.	Was additional craft time given (if required)?		
20.	Was the job coordinated with the shop supervisor(s)?		
21.	Did the planner & shop supervisor(s) agree on the:		
a.	Number of workers?		
b.	Physical contents of the plan?		
c.	Equipment needed?		
d.	Material requirements?		
22.	Was rework required? (explain):		
23.	Were extra personnel used on the job?		
24.	Were worker trainees used?		
25.	Was worker performance satisfactory?		
26.	Were work methods satisfactory?		
27.	Did workers use excessive personal time?		
28.	Did workers report their correct job start & stop times?		

REVIEW DATE:	REVIEWER:	INDUSTRIAL ENGINEER:	DATE:

g. Trend Analysis. Trend analysis is used to track progress of a given element over time, and to predict possible future scenarios by projecting historical data. For the maintenance manager, trend analysis of system performance indicators is an extremely valuable technique in providing insight into the operation of the maintenance management system.

B. MANAGEMENT'S ROLE IN WORK ESTIMATING AND EVALUATION

A well run facilities maintenance management system must include all of the functions discussed previously: work generation, work control, scheduling and accomplishment, and appraisal. As functions of the maintenance management system, they are totally integrated, supporting each other as well as the system as a whole. For work to be performed efficiently and economically, personnel working in the respective functional areas must work together on the common goal of keeping a smooth flow of work moving unimpeded through the system. Personnel in the facilities maintenance organization should be trained to understand their job responsibilities and the effect their work has other functional areas. Standard operating procedures (SOPs) should be developed and periodically updated to ensure that work moves through the system smoothly and efficiently. It is management's responsibility to see that these system requirements are fulfilled.

1. <u>Common Management Shortfalls.</u>

One primary role of maintenance management in a maintenance organization is to be a problem identifier and solver. There is a common tendency however, to focus primarily on current actions and problems and secondarily on upcoming actions and anticipated problems. Without a thorough review and analysis of existing problems and performances, there is a failure to learn from the past and resolve problems before they reoccur. Mistakes, inefficiencies, and low productivity that go undetected or unchanged, can be mistaken as the "normal" way of doing business.

2. <u>Potential Problems.</u>

There are five major problems or situations that frequently occur at a maintenance organization which adversely impact productivity:

- No review of completed work,
- No analysis of deviations (variance analysis),
- "It's not my job" mentality,
- Inaccurate or incomplete reporting, and
- Inadequate or inconsistent follow-up.

Management can best address these situations and the resulting problems through a formally established work appraisal (variance analysis) program. A formal program provides management with a basis to identify existing and potential problem areas, develop alternative solutions, and take corrective actions. A work appraisal program allows management to measure the efficiency of operations and evaluate quality of performance. To be effective, the program should be formalized and regularly scheduled meetings held.

3. <u>Work Appraisal Areas.</u>

Due to the interrelated nature of the various activities in a real property maintenance organization, a work appraisal program must look at problems which have occurred or may potentially occur in each of the maintenance management system components.

a. Work Generation.

(1) A high percentage of work being identified by the customer versus work identified through facility inspection programs and PMI. Work identified by the customer is often a result of problems or situations which have already occurred, placing the maintenance organization in a reactive mode instead of a proactive mode. Productivity of the entire RPMA generally suffers when operating in a reactive (crisis management) mode.

(2) The customer being indecisive or incomplete in defining the scope of work. It is difficult for P/Es to generate accurate estimates against a "moving target". Talking with the customer on a site visit during estimate preparation helps to provide the P/E with insight into what the customer wants, but management needs to stress to the customers to accurately define the work desired at the outset to minimize counterproductive job amendments due to changes in job scope.

b. Work Reception.

(1) The work receptionist inadequately defining the work on the work request. The work receptionist needs to systematically prompt the customer for information regarding the required work when entering the work request. A significant advantage may also be gained if the work receptionist has at least minimal knowledge of the various trades.

(2) Work reception duplicating work requests. Multiple requests for the same work is counterproductive for the entire RPMA organization, e.g. shops responding to Work Requests which have already been assigned and completed.

c. Work Approval.

(1) Management not thoroughly reviewing work requests to assess urgency and funding constraints. Work should not be approved which is not in line with current operating directives. Management must also determine if the work should be given a detailed estimate or scoping estimate.

(2) Approving work which exceeds the capability of the in-house work force to perform. The labor hours for some work (PMI program work, for example) may exceed the available manhours the shops have to perform the work. Work should be screened to determine if it should be performed in-house or by contract.

d. Work Planning and Estimating.

(1) Management not reviewing plans and estimates for quality and completeness. Job sketches and bills of materials should always be included where applicable. Task time for additional material handling, additional work locations, and heavy equipment travel time must be included, if applicable, to avoid underestimating the work.

(2) Planner/estimators not communicating with shop foremen during preparation of estimates. Particularly on larger, more complex jobs, discussing work plans and procedures with shop foremen will likely result in a more accurate and thorough estimate.

e. Material Coordination.

(1) Work delays caused by supply shortages or by incorrect substitute materials being ordered by supply. If insufficient or incorrect materials are available for the job, the work may have to be aborted as scheduled or after work has commenced and the customer's

facilities are in disrepair. Insufficient or inadequate materials is highly detrimental to productivity and may significantly affect the accuracy of estimates.

(2) Failure to segregate or stage materials in supply for scheduled Work Requests. Excessive time craftspersons spend in supply obtaining materials is charged to the job, and excessive time obtaining materials is not generally allowed for during preparation of the estimate.

f. Work Scheduling.

(1) Scheduling conflicts among shops. Well planned estimates are generally phased according to the order crafts appear on the job site. Schedulers must be cognizant of various craft, man-hour, and skill level requirements of each job to avoid scheduling problems and resulting nonproductive hours being charged to jobs.

(2) Scheduler not communicating with shop foremen. Shop foremen must communicate with the scheduler to ensure that previously completed work is removed from the schedule and carryover work is included on the next schedule.

(3) Shop foremen not communicating with other shop foremen. The lead shop foreman on a given job should coordinate with other shop foremen throughout the course of the job to ensure that the crafts appear on the job at the proper time and in the proper sequence.

g. Work Accomplishment.

(1) Lack of supervision and quality control. Administrative requirements of shop foremen should not be so overwhelming as to prevent the foremen from visiting job sites on a routine basis during the day. Shop foremen should be spending approximately half of their day in the field supervising work and expediting work. Shortfalls in this area may significantly impact productivity and job cost.

(2) Failure to recognize and act on shop inefficiencies. Consistently high variances between estimated and actual work may be due to shop inefficiencies such as lack of journeyman level craftspersons, lack of vehicles, lack of proper training, lack of proper tools and equipment, or personnel related problems. Determining where the deficiencies lie is the first step in taking action towards their resolution.

h. Reporting.

(1) Inaccurate reporting of labor hours. Labor hours charged to jobs must not include hours spent on other jobs or hours which should be charged to overhead functions.

(2) Inaccurate and untimely data entry. Large variances may be the result of erroneously entered data from time cards or failing to promptly enter data for jobs prior to generating variance analysis reports.

4. <u>Appraisal Results.</u>

Appraisal results should not be used to place blame on other system components or particular individuals within the organization. Rather, the work appraisal function should serve as a means of identifying work process problems so that continual system improvement can occur. Managers should use the information provided in management reports, performance indicator programs, and system analyses as a basis for making positive corrective changes in the processes supporting the operation and maintenance effort. It does no good to know why work was poorly performed if no corrective actions are taken to change a negative situation into a positive one.

APPENDIX H

BLANK FORMS

JOB PLANNING & ESTIMATING WORKSHEET							1 JOB REFERENCE NUMBER
2 SHOP	3 CRAFT	4 CREW SIZE	5 TRAVEL ZONE	6 JOB PHASE NUMBER	7 CRAFT PHASE NUMBER	8 DATE PREPARED	
9 WORK LOCATION							
10 JOB/CRAFT PHASE DESCRIPTION							

11 REFERENCE	12 TASK OR CHECKPOINT DESCRIPTION	13 UNIT OR CHECKPOINT HOURS (0.00000)	14 JOB OR OCCUR-RENCES (0.0)	15 EPS CRAFT HOURS (0.000)	16 NON EPS ESTIMATED CRAFT HOURS (0.000)
17/18	TOTAL CRAFT HOURS IN (0.000)				
19/20	ALLOWED TIME (TOTAL EPS CRAFT HOURS x GDF OF [ ]) IN (0.0)				
21	TOTAL NON EPS ESTIMATED HOURS IN (0.0)				
22	TOTAL JOB PHASE TIME (ALLOWED TIME + NON EPS TIME) IN WHOLE HOURS				
23	NUMBER OF TIMES OR CYCLES THE JOB IS TO BE PERFORMED				
24	TOTAL LABOR HOUR REQUIREMENT (TOTAL JOB PHASE TIME X NUMBER OF CYCLES)				

JOB PHASE SUMMARY SHEET	JOB REFERENCE NUMBER

JOB PHASE	CRAFT PHASE	DESCRIPTION	LABOR HOURS

JOB ESTIMATE AND COST SUMMARY	JOB REFERENCE NUMBER
WORK LOCATION	
CUSTOMER	SHORT JOB DESCRIPTION

JOB PHASE	CRAFT PHASE	WORK DESCRIPTION	CRAFT	LABOR HOURS	LABOR COST	MATERIAL COST	EQUIP. COST	TOTAL PHASE COST

NOTES	TOTALS					
		CONTINGENCY				%
		OVERHEAD AND/OR SURCHARGE				
		GRAND TOTAL				

AUTHORIZED WORK TO BE PERFORMED (SIGNATURE)	TITLE	DATE

BILL OF MATERIALS

FOR USE OF THIS FORM, SEE DA PAM 420-6; THE PROPONENT AGENCY IS OFFICE OF THE CHIEF OF ENGINEERS.

ACCOUNT CODE NO.		DATE
PREPARED BY	DESIRED DELIVERY DATE	JOB ORDER NO.
DELIVER MATERIAL TO		WORK REQUEST NO.

STOCK OR PART NO.	DESCRIPTION OF ARTICLE	UNIT	QUANTITY	UNIT PRICE	TOTAL COST

GENERAL DATA FACTOR TABLE (NEW ALLOWANCES)

			TRAVEL ZONES															
CRAFT AREAS	CS	Shop	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Boiler	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	M	1.45	1.50	1.52	1.54	1.56	1.59	1.61	1.63	1.69	1.73	1.79	1.84	1.90	1.95	2.08	2.16	2.24
Carpentry (Gen)	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Carpentry (Roofing)	S	1.33	1.36	1.38	1.40	1.42	1.44	1.46	1.48	1.51	1.54	1.59	1.65	1.71	1.77	1.84	1.91	1.99
	M	1.39	1.42	1.44	1.47	1.49	1.51	1.53	1.56	1.58	1.62	1.68	1.74	1.80	1.87	1.94	2.01	2.10
Cooling/Vent/Refr.	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.24	1.27	1.29	1.31	1.32	1.34	1.36	1.38	1.41	1.44	1.49	1.53	1.59	1.64	1.70	1.76	1.83
Electric/Electronic	S	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.38	1.41	1.45	1.50	1.55	1.60	1.66	1.72	1.79
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Heating	S	1.23	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.42	1.46	1.51	1.56	1.62	1.67	1.74	1.80
	M	1.28	1.30	1.32	1.34	1.36	1.38	1.40	1.42	1.44	1.48	1.52	1.57	1.63	1.69	1.75	1.81	1.88
Janitorial	S	1.15	1.17	1.19	1.20	1.22	1.24	1.26	1.27	1.29	1.32	1.36	1.41	1.45	1.50	1.55	1.61	1.67
	M	1.17	1.19	1.21	1.23	1.25	1.26	1.28	1.30	1.32	1.35	1.39	1.44	1.49	1.54	1.59	1.65	1.71
Machine Shop	S	1.30	1.33	1.35	1.37	1.39	1.41	1.43	1.45	1.47	1.51	1.55	1.61	1.66	1.72	1.78	1.85	1.92
	M	1.31	1.34	1.37	1.39	1.41	1.43	1.45	1.48	1.50	1.54	1.59	1.64	1.70	1.76	1.83	1.90	1.97
Machine Repairs	S	1.39	1.42	1.43	1.45	1.48	1.50	1.52	1.53	1.57	1.60	1.65	1.72	1.77	1.84	1.91	1.98	2.06
	M	1.49	1.53	1.55	1.57	1.59	1.62	1.64	1.70	1.72	1.77	1.82	1.87	1.93	2.05	2.11	2.20	2.27
Masonry (Gen)	S	1.23	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.42	1.46	1.51	1.56	1.62	1.68	1.74	1.81
	M	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.44	1.46	1.49	1.54	1.59	1.65	1.71	1.77	1.84	1.91
Masonry (Purchased)	S	1.27	1.30	1.32	1.34	1.36	1.38	1.40	1.42	1.44	1.47	1.52	1.57	1.62	1.68	1.74	1.81	1.88
	M	1.31	1.34	1.36	1.38	1.40	1.42	1.44	1.46	1.48	1.52	1.57	1.62	1.68	1.74	1.80	1.87	1.94
Moving/Rigging	S	1.35	1.38	1.40	1.42	1.44	1.47	1.49	1.51	1.53	1.57	1.62	1.67	1.73	1.79	1.86	1.93	2.00
	M	1.49	1.53	1.55	1.57	1.60	1.62	1.65	1.67	1.70	1.74	1.80	1.86	1.93	2.00	2.07	2.15	2.24
Multi-Trade	S	1.23	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.42	1.46	1.51	1.56	1.62	1.67	1.74	1.80
	M	1.28	1.30	1.32	1.34	1.36	1.38	1.40	1.42	1.44	1.48	1.52	1.57	1.63	1.69	1.75	1.81	1.88
Paint (Gen)	S	1.20	1.23	1.24	1.26	1.28	1.29	1.31	1.33	1.35	1.38	1.43	1.47	1.52	1.57	1.63	1.68	1.75
	M	1.21	1.24	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.40	1.44	1.49	1.54	1.59	1.65	1.71	1.78
Paint (Spray)	S	1.21	1.24	1.25	1.27	1.29	1.31	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.58	1.64	1.70	1.76
	M	1.23	1.26	1.28	1.30	1.31	1.33	1.35	1.37	1.39	1.43	1.47	1.52	1.57	1.62	1.68	1.74	1.81
Pest Control	S	1.18	1.21	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.37	1.41	1.46	1.51	1.56	1.61	1.67	1.74
	M	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.39	1.42	1.47	1.52	1.57	1.62	1.68	1.75	1.82
Pipefitting (Int)	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Pipefitting (Ext)	S	1.24	1.27	1.28	1.30	1.32	1.34	1.36	1.38	1.40	1.43	1.48	1.53	1.58	1.63	1.69	1.75	1.82
	M	1.32	1.35	1.37	1.39	1.41	1.43	1.45	1.47	1.49	1.53	1.58	1.63	1.68	1.74	1.81	1.87	1.95
Plumbing (Int)	S	1.23	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.42	1.46	1.51	1.56	1.62	1.67	1.74	1.80
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Plumbing (Ext)	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Roads & Grounds (Gen)	S	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.38	1.41	1.45	1.50	1.55	1.60	1.66	1.72	1.79
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Roads & Grounds (Labor)	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Sheetmetal	S	1.21	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Stru Iron/Weld (Shop)	S	1.23	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.42	1.46	1.51	1.56	1.62	1.67	1.74	1.80
	M	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.46	1.51	1.56	1.61	1.67	1.73	1.80	1.86
Stru Iron/Weld (Fld)	S	1.29	1.32	1.34	1.36	1.38	1.40	1.42	1.44	1.46	1.50	1.55	1.60	1.66	1.72	1.79	1.86	1.93
	M	1.36	1.38	1.41	1.43	1.45	1.47	1.49	1.52	1.54	1.58	1.63	1.69	1.75	1.82	1.89	1.96	2.04
Trackage	S	1.31	1.34	1.36	1.38	1.40	1.42	1.44	1.46	1.49	1.52	1.57	1.63	1.68	1.74	1.81	1.88	1.95
	M	1.32	1.35	1.37	1.39	1.41	1.43	1.46	1.48	1.50	1.54	1.59	1.65	1.71	1.77	1.84	1.91	1.99
Wharfbuilding	S	1.36	1.39	1.41	1.43	1.45	1.47	1.49	1.52	1.54	1.58	1.63	1.69	1.75	1.81	1.88	1.96	2.03
	M	1.46	1.49	1.52	1.54	1.57	1.59	1.62	1.64	1.67	1.71	1.77	1.83	1.90	1.97	2.05	2.13	2.22

1. Crewsizes over 6, add 0.1 to GDF. 2. Hazardous work add 0.1 to GDF. 3. Return for lunch: TZ's 2-5 add 0.1; 6-9 add 0.2; 10+ add 0.3.

APPENDIX I

ESTIMATING DESK GUIDE GLOSSARY

GLOSSARY

Accomplishment.
Performance of wok in accordance with a schedule and job plan within acceptable levels of quality.

Actual Labor Hours.
The time taken by a worker to complete a task.

Additional Material Handling.
Time allowed to move materials from one location to another.

Additional Work Location.
Time allowed for craftspersons to move to different locations either within a facility, between facilities, or within the same travel sector.

Allowance.
Time added to "craft time" to compensate the worker for time lost because of balancing delays, planning, personal, unavoidable and in some cases special delays.

Allowed Time.
When the EPS Craft Data is multiplied by the appropriate (and if necessary adjusted) General Data Factor.

Appraisal.
Facilities maintenance management system function in which managers examine variances between actual and estimated work requirements, perform work analysis and trend analysis to identify system process problems and eliminate their recurrence.

Avoidable Delay.
Waiting for material that should have been staged at the job site prior to the craftsperson's arrival, returning to the shop to get more tools, untrained labor, and other delays that can be controlled by managers.

Balancing Delay.
During a job, there are times when one of the workers cannot proceed or continue work until work performed by others is completed.

Bill of Materials.
Concise listing of materials, parts, and quantities required to perform the work in each job phase of the work sequence.

Checkpoints.
Checkpoints are EPS task operations used in Preventive Maintenance Inspection estimates.

Command Inspections.

Inspections which occur on a scheduled or unscheduled basis to determine maintenance, safety, or health deficiencies.

Contract Data.

Information related to labor, material, and equipment costs provided in contract estimates and contract invoices.

Craft Allowances.

A percentage of craft time that either supports the accomplishment of the job or is an unavoidable delay that is an inherent part of facilities maintenance repair work and cannot be avoided. It includes planning, balancing delays, personal time, and unavoidable delays.

Craft Handbook.

A Handbook of EPS times values for tasks performed by a particular craft.

Craft Phase.

The sequence of phases in which a craft or work center appears at the job site to perform a job phase.

Craft Time Adjustment (CTA).

A factor which may be used to slightly modify EPS task time standards so that they can be applied to a wider range of work requirements.

Cycles.

Is the number of repetitions a job is to be performed in a one year period. For example if a job requirement is stated as twice monthly the number of cycles to be applied to the total job phase time (the total amount of time required to perform the job one complete cycle) is 24 cycles or monthly times two.

Delay.

A period of time in which conditions do not permit or require immediate performance of the next planned work action.

Desk Top Estimates.

A type of scoping estimated developed at the Planner/Estimator's desk to provide a ball park estimate accurate to within ± 25%.

Detailed Estimate.

Estimates developed to determine specific work requirements, work sequencing, craft tasks, labor hours, specific material and equipment quantities, and total dollars required.

Element.

The smallest unit of work used in a standard. A composition of basic motions and/or machine or process activities that are distinct, desirable and measurable. Examples are pick up tool, measure board etc.

Emergency Work.

Work required to immediately correct conditions that may impact on the mission, safety, health or operational effectiveness of the organization.

Engineered Performance Standards.

Time standards developed for maintenance and repair work by engineers using proven industrial engineering techniques that when properly applied represent the average time necessary for a qualified worker, working at a normal pace, under capable supervision and experiencing normal delays, to perform a defined amount of work of a specified quality while following acceptable trade practices.

Estimating.

Process used to determine requirements, plans, and estimates to accomplish a defined amount of work.

Experience.

Source of work estimating data based on the estimating and/or craft experience of an individual.

Fabricate.

To create a part, piece or item to be installed.

Facilities Maintenance Management System.

A completely integrated group of components which provides control over facilities maintenance from beginning to end.

Funded Estimate.

Form of scoping estimated more accurate than a desk top estimate used to obligate resources.

General Data.

Data that is general in nature and does not apply to any specific type of operation, but to an entire installation, craft or work center. For example , travel time, craft allowance and job preparation.

General Data Factor (GDF).

Factor applied to EPS craft time to add travel time, job preparation, and craft allowances to compute the total allowed job time for the phase.

Hazardous Work Situation.

When a normally non hazardous job is found to have some hazardous situation related to it, job preparation time can be increased by adding adjustment of 0.1 to the General Data Factor for the craft.

Heavy Equipment Travel.

Additional travel time allowed for heavy or large equipment which normally travel at below normal speeds.

Historical Information.

Source of work estimating data generally found at an installation in hard copy or electronic format based on past work performed.

Inspection Estimate.

Form of scoping estimate developed as a part of the facilities condition inspection program by inspectors which are used in determining near term accomplishment or backlog requirements.

Inspection Program.

A formal program within the Work Generation function of the Facilities Maintenance Management system to pro-actively identify installation maintenance and repair requirements.

Install.

To fix in position materials, parts, equipment, or fabricated items.

Job.

A series of tasks that when completed , satisfy the scope of work requested on a work order.

Job Estimate and Cost Summary Sheet.

A summarization of the work to be performed, the total hours by craft area, total labor cost, total material cost, total equipment cost, and total cost for each phase.

Job Phase.

The sequence of phases for work accomplishment.

Job Phase Summary Sheet.

A form which provides a list of job phases in the order of recommended accomplishment, the craft area involved, the labor hours required, and the phase description with all details of the work.

Job Reference Number.

Work Request document number of the job for which the estimate is being prepared.

Job Planning & Estimating Worksheet.

Form used in EPS Estimating to compute the total labor hour requirement for each phase.

Job Preparation.

Time to get ready for the job and time to "finish up" after the craft work has been completed.

Job Setup Time.

A task time requirement per job or work location within a task time standard to used to account for machine setup or work site preparation.

Ladder Time.

Time allowed to use a ladder in performing a task.

Maintenance Management.

An integrated system designed to provide control over maintenance work from beginning to end.

Maintenance and Repair Standard.

A time standard for maintenance work.

Methods Time Measurement (MTM).

A system of predetermined time standards which provides a precise measuring method for human motions. It is used as the basis for Engineered Performance Standards development.

NAVFAC Industrial Engineering Center (NIEC).

The NIEC is a Department of Defense (DOD) organization consisting of industrial engineers and technicians located in Norfolk, Virginia, whose responsibility is to validate, revise, develop and publish EPS materials for all DOD components.

Non EPS Estimated Craft Hours.

These are estimated times from any standard other than EPS. These are expressed to three decimal places in the Non-EPS Estimate Craft Hours column of the JP&E Worksheet.

New Construction Standard.

Standard for new construction work.

Non-EPS Task.

In using EPS as the primary source for developing facilities maintenance and repair estimates, EPS application records all other sources of standards and other categories of estimating information as non EPS.

Occurrence.

A factor of the amount of work in the task being estimated divided by the amount of work in the EPS task to which it is being compared.

Official Delay.

Time to attend safety meetings, go to the dispensary, etc.

Operation.

A series of related EPS elements performed by a workers that results in a desirable change in location or condition of maintenance materials or parts.

Partial Day Influence.

Time added for additional travel and job preparation time required by the majority of jobs performed.

Performance Indicators.

Facilities maintenance management system management tool to provide data for comparative analysis in order to determine where system process problems exist and identify corrective actions to be taken to improve productivity and efficiency within the organization.

Personal Delay.

Time during the course of a job to attend to personal needs as well as to rest when strenuous work is being performed.

Phase.

The amount of work that can be completed by one craft or work center without interruption from other crafts or work centers.

Piece Time.

Time provided for the accomplishment of operations associated with items or pieces to be produced.

Planning.

Time for pertinent discussions among the crew about what is to be done, checking specifications and job plans, reading blue prints, taking measurements, and marking the work site.

Planning and Estimating.

In the work control function of the facilities maintenance management system, approved Work Requests are planned and estimated to determine labor hours, material, equipment, and costs.

Planner/Estimators.

Individuals in the RPMA organization who are tasked with planning jobs and estimating the labor hours, material, equipment, and money. Other titles exist throughout DOD.

Planning Allowance.

At various intervals during the accomplishment of a job, on the job planning is required. This time includes pertinent discussions among the crew members as to what is to be done and by whom, checking specifications and job plans, reading blue prints, taking measurements and marking the work site.

Preventive Maintenance and Inspection (PMI).

Planned, periodic maintenance work requirements for dynamic and static equipment that ensure the continued operation and extended life of a given piece of equipment by minimizing major repairs..

Preventive Maintenance and Inspection (PMI) System.

A FEJE module developed for the automated EPS application of Preventive/Recurring Maintenance.

Production Standard.

A time standard for production work (such as vehicle assembly).

Proprietary Standards.

Standards developed by individuals and corporations in the private sector that are protected by copyright.

Public Domain Standards.

Standards available in the public domain, in most cases, have been developed either for or by the government and are not protected by copyright.

Recurring Work.

Maintenance work performed on a recurring basis which has strictly defined work content, does not encompass breakdown maintenance or repair, and is performed at repetitively scheduled frequencies.

Reinstall.

Refers only to the attachment, connection or mounting of a part or piece of equipment (same or identical model) to a position from which the part or equipment had been removed. A reinstall task does not include removal operations.

Remove.

To take, extract, or separate materials, parts, equipment, or fabricated items from a fixed position.

Replace.

To remove and install materials, parts, equipment, or fabricated items in a fixed position.

Scaffolding Time.

Time allowed to assemble or disassemble, move, raise, and lower scaffolding based on the number of scaffold sections required for the job.

Scheduling.

Assignment of labor resources to identified work requirements for accomplishment in a defined time frame.

Scoping Estimates.

Scoping estimates are preliminary, "ball-park", estimates used in the work control screening process to determine if the requested work should be performed.

Sector.

A concept used in conjunction with a travel zone map to determine the amount of additional travel time to add to a job when it is done in numerous locations in the same travel zone but some are in opposite directions from the shop "starting point".

Service Calls.

Maintenance and repair work which is routine in nature and can be accomplished in a small number of hours. Service call work by definition is not normally estimated because it does not require phasing, shop coordination, scheduling, or extensive material requirements.

Standard.

A measure of comparison or acceptability used as a benchmark or yardstick for measuring actual performance.

Standby/Safety Time.

Time allowed for a safety person or standby person in support of the craftsperson(s) performing the task.

Task.

A combination of operations that result in a specific amount of work that can be performed by a single craft with a specified time required to accomplish it.

Task Time Standard.

The specified amount of labor hours associated with a specific task, task unit or checkpoint. There are EPS Task Time Standards incorporated in the individual Craft Handbooks and there are Non-EPS Task Time Standards that are incorporated in commercial estimating reference books such as Richardsons™ and Means™.

Time Measurement Unit (TMU).

A time unit equal to .00001 hour; used in the application of MTM to avoid the constant use of smaller decimal numbers in determining element time.

Time Study.

A method of accurately measuring work with a stopwatch. Used in EPS to determine the amount of time for elements not fully controlled by workers and for Travel Zone Map development.

Total Job Phase Time.

Includes all time estimated to perform the work described in the phase. It includes both EPS and Non-EPS craft hours and all allowances and travel time required to perform the work.

Total Labor Hour Requirement.

Is the total job phase time multiplied by the number of times or cycles a job is to be performed.

Traffic Striping Machine Time.

Time allowed at the end of each day to clean the paint striping machine during road marking jobs.

Travel Sector.

A portion of a Travel Zone Map determined by drawing a perpendicular lines on the Travel Zone Map.

Travel Time.

One round trip, per craftsperson, per day between the shop and the job site.

Travel Zone.

An area designated on an installation Travel Zone Map (or listing developed from the travel zone map) which represents travel time from the maintenance shops to the various work locations on the installation (and to remote sites and sub installations). The travel zone of the job site is one of the factors used by the planner-estimator to select the appropriate GDF to apply to the EPS craft hours.

Travel Zone Map.

A map of the EPS travel times at a specific installation.

Unit Hours.

A task time for a specific measurable quantity of work (length, area, each, etc.) expressed in whole hours and 5 decimal places 0.00000.

Unit of Measure and Issue.

An indicator of the units in which a task quantity is measured such as linear feet, square feet cubic yards etc. The task unit of measure may not always coincide with the supply issue unit of measure for example the task unit of measure for floor tile is in Square Feet (SF) whereas the supply unit of measure for tile is Box (BX).

Universal Data.

Engineered Performance Standards task time applicable to all crafts.

Variance Analysis.

The difference between Estimated EPS hours and actual expended hours on a phase or job is a variance. Because EPS is centered around standards, an unacceptable variance from the standard must have a logical explanation. An analysis of the reasons for the variance will provide management information upon which to initiate action to eliminate those variances on future similar work.

Watchstanding/Plant Operations.

Routine operator maintenance, inspection, and observation performed on a recurring basis throughout scheduled blocks of time during a specified period of time (e.g. hours, shift, day). It does not include time for breakdown and repair maintenance.

Work Content Comparison.

Comparing work in the work requirement to be estimated to work in the EPS standard to determine if the operations are comparable and the standard applicable to the work requirement.

Work Control.

Facilities maintenance management system function which enables the large input of work from work generation to be handled efficiently and effectively based on criteria such as cost, urgency, and capability. Within the work control function, work is screened and approved for accomplishment.

Work Estimating.

The process used to determine work requirements, plan the work, and estimate the labor, material, and equipment for a defined amount of work.

Work Generation.

Facilities maintenance management system component in which work is identified by inspection programs, service calls, Work Requests, and command inspections.

Work Package.

An assembly of all work related documents associated with the Work Request. It generally includes the Work Request, a Job Estimating Summary, a Job Phase Summary Sheet, a Bill of Materials, JP&E Worksheet(s), and applicable Sketches/Drawings.

Work Plan.

Plan for work accomplishment which includes the craft sequence, rough sketches and drawings of the work site, a list of the work tasks to be performed, a list of the materials and equipment required, and an estimate of the labor requirements and funds required to accomplish the work requirements.

Work Request.

Form used to request maintenance work beyond the scope of a Service Call generated by authorized installation customers.

Work Reception.

The point in the facilities maintenance management system work control function where all identified work enters into the facilities maintenance management system.

Work Sampling.

An industrial engineering technique used primarily in EPS to determine the percentages of work or delays associated with EPS allowances.

Work Scheduling and Accomplishment.

Facilities maintenance management system function in which work is scheduled for accomplishment and accomplished by the shops or contract.

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